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BUTTERFAT PRODUCTION IN NEW ZEALAND.

FACTORS INFLUENCING UNIT-AREA PRODUCTION, WITH SPECIAL REFERENCE TO MILK-TEST.

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INTRODUCTION.

THE standard of butterfat production per unit of area farmed is generally accepted as the measurement of production efficiency under any given set of circumstances. As a standard of measurement this is fundamentally correct, since, when used in conjunction with maintenance and working costs, a final picture of the degree of management efficiency is obtained for the conditions subscribed. The standard of production attained, unfortunately, does not disclose the organization responsible for such a standard. Similar results can be procured from a variety of combinations, the component parts of which may or may not be balanced to ensure full exploitation of potential production.

It has been repeatedly impressed upon dairy-farmers that the most effective method of reducing unit production costs under any capital position is to obtain a greater volume of output per unit of area farmed. This is particularly true where the object may be achieved by a re-adjustment of production factors rather than by a gross increase in working expenses. Undoubtedly the most certain cost reduction resulting from production increase is in the spread of capital costs. It is significant, however, that under the semi-static conditions prevailing prior to the present price depression, expenses other than labour and interest showed a per-unit variation of approximately 20 per cent. for the production range 100–150 lb. of butterfat per acre.

In view of the pertinence of this established fact, the importance of studies into methods calculated to increase unit area production cannot be overestimated. With a dead load of capital debt, plus an elusive factor represented by cash put into farms and known as "farmer's equity," the exploitation of unit area production as a direct method of reducing unit production costs assumes a wider significance than the welfare of individual farmers, as national readjustments and financial stability are directly involved.

It should be recognized that dairying and its natural sideline activities represent the one branch of primary production which offers

great scope for a rapid increase in volume of output. There is no reason why our exportable surplus of butterfat should not be raised by 50 per cent. above its present level in a comparatively short space of time. Even at present price-levels this would represent a tremendous advance in trading power, and the dairy industry therefore has an obligation to the State in view of its potentially strong position. If the present price-level for all primary products is the standard on which the future must be based, then dairying constitutes the major industry which has reasonable chances of meeting a fair proportion of its capital commitments. To do so, however, the seriousness of the position and the responsibility of producers in the State fabric must be fully appreciated, so that governing bodies and farmers may be prepared to co-ordinate dairying activities in a manner calculated to attain a definite objective in as short a space of time as is possible.

In the following discussion an endeavour has been made to present some aspects of farm organization in such a way that dairy-farmers and those interested in the industry may obtain a clearer view of the structure on which the standard of production depends.

Source and Reliability of Data.

The data on which this analysis is based pertain to a total of 967 farm records. The greater portion—namely, 677 farms—are situated in the Middle Waikato Basin and the Bay of Plenty, the production figures applying to the season 1929–30. The remaining 290 instances are from Northern Taranaki.

The source of information was primarily from herd-testing records, farm areas being supplied by farmers themselves, or checked from official records. The reliability of the data is therefore backed by the testing movement. "Cows carried" was taken as that number recorded for the testing period showing the greatest number irrespective of the date. As all cows are tested on testing farms this should be a reliable basis for computing carrying-capacity. The sample of farms was in no way picked, their inclusion depending entirely upon the possession of and facility to check areas. It can therefore be said that sampling depended to a great extent on chance. They can be looked upon as a reasonable average of testing farms for the season 1929–30, but consequently above the average for all farms in the Dominion so far as per-cow and per-acre production are concerned. The 967 farms have an aggregate area of 137,557 acres, and milked 52,385 cows.

For the purposes of analysis farms have been treated under six district headings, each district being, within limits, comparable within itself so far as type is concerned, while there is a wide variation between districts. This variation depends mainly upon the standard of exploitation reached in land utilization, districts having a large percentage of land of an unproductive nature within farm boundaries naturally showing an adverse unit-area production position. It is obvious that the type of farm does not influence management in deciding on the type of cow to be milked. A further factor influencing the range of production between districts is the incidence of cow type within the areas prescribed. It is apparent that in some localities there has not been such a general departure from the foundation stock of the district through importation of replacements.

The question as to whether production should be based on total farm area or only on that area producing milking pastures, is one which presents great difficulties. Undoubtedly the net production area should be taken to obtain a true picture of cause and effect, as the percentage variation in production to total area is very great. An attempt was made to procure a break-up of farm areas, but the results proved that it is not possible to obtain a true production area without incurring considerable expense. As New Zealand farm conditions are being discussed, and as most dairy-farms contain a proportion of unproductive land, it is considered that the number of farms treated is sufficient to reasonably smooth inequalities, and to afford a fair presentation of facts under the average farming conditions to be found in our main dairying districts.

Factors influencing and controlling the Standard of Production per Unit of Area.

In the final analysis, production per unit of area is determined absolutely by (1) area of farm, (2) number of cows milked, and (3) average production of butterfat per cow milked. Production per acre is therefore determined by the equation

$$\frac{\text{Cows milked} \times \text{average butterfat per cow}}{\text{Area of farm}}$$

Once this equation is established for any farm, no other figure can be added to influence the final result. Therefore farm management or organization aiming at an increased unit-area output must aim at influencing the unstable factors comprising the equation. As farm area is not readily adjustable the attack must be on carrying-capacity and cow performance.

It is very apparent that it is desirable and that there is room to effect a change in the big majority of dairy-farms. In Table 1 is presented a most illuminating picture of the average conditions prevailing on farms which are undoubtedly above the average in degree of exploitation. This would suggest that if an average could be taken over

Table 1.—Farms grouped according to Butterfat produced per Acre (Unweighted Averages).

Butterfat per Acre Range.	Number of Farms in Group.	Percentage of Farms in Group.	Average Cows per Farm.	Average Size of Farm.	Average Test.	Average Milk per Cow.	Average Butterfat per Cow.	Average Cows per 100 Acres.	Average Milk per Acre.
lb.				Acres.	Per Cent.	lb.	lb.		lb.
25–50 ..	40	4·14	52	258	4·4	5,053	224	20·8	1,030
50–75 ..	156	16·13	53	201	4·4	5,418	239	27·0	1,452
75–100 ..	208	21·51	53	151	4·5	5,697	255	35·2	1,977
100–125 ..	242	25·03	54	130	4·6	5,926	270	42·1	2,463
125–150 ..	146	15·10	55	112	4·6	6,093	281	49·3	2,976
150–175 ..	94	9·72	54	100	4·7	6,441	303	54·2	3,462
175–200 ..	47	4·86	56	92	4·8	6,444	307	61·2	3,892
200–225 ..	22	2·27	58	86	4·8	6,483	309	69·2	4,439
225–250 ..	8	0·83	79	104	4·9	6,318	311	77·1	4,789
250–275 ..	1	0·10	39	48	4·9	6,732	329	81·2	5,470
300–325 ..	3	0·31	72	83	4·9	7,213	357	86·1	6,225

all farms in New Zealand a much lower scale of production would be presented than found in this table. The percentage of farms falling within low per-acre groups would be materially increased, and would show the real scope for improvement in output to better advantage.

When studying this table it should be remembered that average per-cow production reached a peak in 1929–30, the average for the Dominion in that period being 218 lb. of butterfat. The next highest average yield was that of 211 lb. for the previous season (1928–29). Herd-testing records also show that the season under discussion established a record, figures for all group-tested cows averaging 253·61 lb. butterfat, while the next best season's performance was 241·05 lb. per cow.

It will be noticed that 77·77 per cent. of the total farms fall within the 50–150 lb. butterfat per-acre range, and that farms producing more than 150 lb. per acre are comparatively rare, even in a good season. The average for the 967 farms is in the vicinity of 112 lb. of butterfat per acre, clearly indicating the scope for improvement on low-production farms, and on those grouped round the average.

In the sample taken the size of milking herds does not vary materially, but large farms are directly associated with low-scale production. This is undoubtedly due to less intensification of stock and inferior exploitation of land, a labour and liquid capital scarcity resulting in an unbalance between stock and potential food supply.

The percentage butterfat content of milk as expressed by test shows that animals producing high-test milk are more generally found on high per-acre production farms than the reverse. The range of movement in test under this system of grouping is not great, however, indicating that herds of all types are to be found in any production group. This is substantiated by the movement in average milk yields. The fact that average milk yields vary from approximately 5,400 lb. in the 50–75 lb. per acre group to almost 6,500 lb. in the 200–225 lb. group suggests further that low-test animals, particularly in the low-production groups, have not received the treatment necessary for maximum production, as from a physiological viewpoint low-test cows should on the average produce a greater bulk of milk than high-test animals. The position operating on New Zealand farms as disclosed by this analysis automatically ensures that, when an increasing test is combined with an increasing milk-yield, the resultant per-cow production rises with increased per-acre output at a rate which is sharper than should actually be the case if all animals were fed in a manner calculated to fully exploit their production capabilities.

The most potent factor influencing per-acre production is the number of cows milked per unit of acre farmed. The data under discussion reveal an extremely wide range of variation, amounting to well over 100 per cent. It has been mathematically established from a detailed study of the 144 Bay of Plenty farms included in this analysis that the movement in per-acre production is influenced by carrying-capacity and per-cow production in the ratio of two to one.

This analysis substantiates the contention which so often has been made—namely, that the first line of attack in an endeavour to increase unit-area output should be an increased carrying-capacity of milking

cows. If this can be achieved coincident with an improved milking strain of animals, then the movement in output is materially accelerated.

The yield of milk per acre naturally moves in accordance with the other features which go to make up the range of per-acre production.

Farmers' Control over Production Standard.

The farmers' immediate control over the per-acre unit standard of butterfat production is determined through internal organization and food supply. Once these factors have been fixed the influence of animal type as exemplified by body structure and milk test is beyond his immediate jurisdiction. Therefore factors determining the production level can be divided into three categories: (1) Organization; (2) management; (3) animal type. The third feature is inseparable from the first, and is controlled by the farmer in deciding his stock organization. The decision is, however, often made without due consideration being given to its influence on production, and therefore demands separate treatment.

Organization is directly concerned with stock and with the internal arrangement of the farm itself, but particularly with stock so far as it pertains to this discussion. The type of animal chosen determines within narrow limits the percentage butterfat content of milk produced. Their potential production-capacity is determined by the strain of producers included in the herd and the sire put at its head. Once these arrangements are made, the final volume of output is controlled by management, with an unknown quantity known as climatic conditions influencing the results. The fact that climatic conditions can so materially affect output only substantiates the contention that management efficiency can also account for a wide range of exploitation of strain potentialities, as management can to some extent flatten out the ill effects of adverse climate.

The flexibility of cow performance has been admirably demonstrated during the past three seasons. The Dominion average for all cows in milk or dry rose to a peak of over 218 lb. in the season 1929–30. In the following season it dropped to 201 lb., and for the present season (1931–32) the average will be in the vicinity of 185–190 lb. This drop is due to climatic conditions, aggravated by a most unfortunate set of circumstances resulting in a diminution of fertilizer usage to the extent of 130,000 tons below requirements based on the quantity used for the production season 1929–30. This has undoubtedly restricted management, particularly in the conversion of surplus pasturage into food reserve, to say nothing of the depletion of plant-food reserves in the soil itself.

It cannot be accepted that the general level of stock potentiality has dropped, even though herd-testing figures show a reduction in the percentage of cows tested registering above 250 lb. We therefore come back to the fact that when stock organization is fixed and climatic conditions are constant the level of per-acre production is determined by efficiency in management, whether it tends toward an increased density of milking cows or to exploitation of the capabilities of the herd. Maximum exploitation under fixed stock conditions is therefore a question of quantity and quality of food supply, and affects unit-area production through the ability to milk more cows and to improve

individual cow performance. It is not suggested that the range of carrying-capacity and average yield as illustrated in the 967 farms analysed is due entirely to a similar range in management efficiency. It is nevertheless true that farms falling within any group within the range have a wide margin of variability, and can be raised or lowered in the scale by varying farm management.

CARRYING-CAPACITY.

The average conditions accompanying a range of carrying-capacities and herd averages can now be studied in some detail. As previously stated the term carrying-capacity is used to denote the total number of cows milked on individual farms at any time during the season. If a complete balance is maintained, carrying-capacity is determined by the volume and quality of food produced combined with the consumption requirements of dairy cows. Their consumption needs are determined by their potential productive capacity plus the amount required to maintain body weight. Thus, with a fixed food provision, the ratio between body weight and productive capacity per unit of weight should be as wide as possible.

How are these features balanced under average farm conditions, and what is the effect of the degree of efficiency prevailing on the ultimate measure of production efficiency? Table 2 affords data along these lines for the farms under review.

Table 2.—Farms grouped according to Carrying-capacity per 100 Acres (Unweighted Averages).

Cows Milked per 100 Acres Range.	Number of Farms in Groups.	Percentage of Farms in Groups.	Average Number of Cows in Herds.	Average Size of Farms.	Average Butterfat per Cow.	Average Milk per Cow.	Average Test.	Average Butterfat per Acre.	Average Milk per Acre.
				Acres.	lb.	lb.	Per Cent.	lb.	lb.
Under 30..	197	20·37	50	208	257	5,668	4·5	63·1	1,391
30–40 ..	260	26·89	54	153	263	5,848	4·5	93·2	2,080
40–50 ..	275	28·44	55	123	271	5,926	4·6	120·8	2,629
50–60 ..	155	16·03	56	104	278	6,082	4·6	151·4	3,302
60–70 ..	52	5·38	60	92	283	5,965	4·7	180·5	3,825
70–80 ..	18	1·86	60	81	268	5,789	4·6	197·6	4,275
80–90 ..	8	0·83	51	62	295	6,228	4·7	245·0	5,180
90–100 ..	1	0·10	90	100	356	7,225	4·9	320·4	6,503
100–110 ..	1	0·10	102	100	227	4,652	4·9	231·3	4,745

NOTE.—The last three groups can be ignored owing to small numbers.

It will be seen that the average carrying-capacity for all farms under review is comparatively low, amounting as it does to 41·6 cows per 100 acres. If this set of farms is accepted as a fair sample of the better-class farm and management, it is apparent that instances of very high carrying-capacities so often heard of are remarkably rare when all the facts are studied.

The size of herds does not materially affect carrying-capacity, although the number of cows in herds of greatest density tends to increase. The size of farms in relationship to cow density, however, is very marked.

The range of variation in milk and test, and consequently in butterfat per cow, is very narrow, particularly for those groups below eighty cows

per 100 acres. The significance of this fact is that all types and strains of cows are to be found in herds of varying intensity, with the suggestion that low-test herds are more likely to be found in the lower carrying-capacity groups. The direct relationship between cow density and production of butterfat and milk per unit of area is very marked, as when arranged in this way it is evident that these two results are mainly determined by the number of effective milking cows carried on a given area.

Production per Cow.

The productive quality of a herd is determined by the inherent productive ability of its individual units. Its potential capacity is never fully exploited under average farm conditions, as the quantity and quality of the food supply can never be perfectly balanced with the complete requirements of the herd. It is a well-known fact that individual animals receiving special treatment when entered for the C.O.R. test will produce much higher than under average herd conditions. Herd averages may also be detrimentally affected by undue exploitation of carrying-capacity. Thus it is possible for any herd to vary its position in the production range from season to season, the movement being in either direction according to treatment and conditions despite its inherent capacity to produce. Herd average is undoubtedly the most unstable factor controlling the standard of unit-area production.

The conditions surrounding and facts resultant from the variation in herd averages as found in the farms under review will be seen in the following table :—

Table 3.—Farms grouped according to Herd Average of Butterfat per Cow (Unweighted Averages).

Herd Average Butterfat per Cow Range.	Number of Farms.	Percentage of Farms.	Average Number of Cows.	Average Size of Farm.	Average Test.	Average Milk per Cow.	Average Number of Cows per 100 Acres.	Average Butterfat per Acre.	Average Milk per Acre.
lb.				Acres.	Per Cent.	lb.		lb.	lb.
150–175 ..	6	0·62	46	129	4·4	3,795	39·6	64·8	1,508
175–200 ..	44	4·55	59	181	4·3	4,441	35·6	67·2	1,614
200–225 ..	84	8·69	58	163	4·4	4,884	37·8	80·9	1,842
225–250 ..	198	20·47	58	158	4·4	5,465	39·9	95·1	2,185
250–275 ..	223	23·07	52	138	4·5	5,794	41·5	108·4	2,398
275–300 ..	196	20·27	53	132	4·7	6,174	43·4	124·4	2,662
300–325 ..	121	12·51	52	130	4·7	6,656	44·0	136·6	2,919
325–350 ..	68	7·03	50	122	4·9	6,849	43·7	146·7	2,998
350–375 ..	23	2·38	52	114	4·9	7,372	48·5	175·7	3,585
375–400 ..	3	0·31	45	98	4·8	8,174	45·9	177·9	3,752
400–425 ..	1	0·10	67	160	5·3	7,810	41·9	168·6	3,270

The average per-cow production over the 967 herds, as discussed above, amounted to 268 lb. of butterfat. The average for all cows in the Dominion was 218 lb. for the season 1929–30, and if the modal group were moved back to the 200–225 lb. position, as it would be if all farms could be included in the analysis, the percentage distribution would be materially affected.

The size of herd is comparatively stable throughout, and the size of farm is not such an important factor in association with herd averages as with cow density. There is, nevertheless, a trend toward a decrease in area as per-cow production increases, but it appears that all grades of herd averages may be found on farms of any particular area.

The movement in milk-test and milk produced per cow indicates again that under average farm conditions in New Zealand the type of cow giving a high milk-test has an advantage over those of low test. Although the comparative flatness of test range shows that all types of animals are to be found in any cow production group, high-testing herds are more numerous in the higher ranges of per-cow output.

The standard of per-cow production is controlled by test and milk yields. The fact that low-test animals have greater milk-secretion capabilities stresses the point that a proportion of such herds are included in the high productive groups. If these herds had been fully exploited they should have been more generally included in the higher ranges, which would have resulted in a still flatter range of test. It would also have exerted a similar influence on carrying-capacity, and on yield per acre.

Under the conditions prevailing, however, it is found that herds with high averages are associated with increased carrying-capacity, the combination of which result in rapid movement of unit-area production both of butterfat and milk.

Cow Type and its Influence on the Production Standard.

In the foregoing discussion factors of organization and management have been reviewed, which are subject to variation under a range of management and climatic conditions. It has been necessary to treat them in some detail to show that herds of any type (as signified by milk-test) are, under average farm conditions, found throughout the whole range of herd averages, cow densities, and unit-area production. The discussion up to this point has aimed to show that the method of random sampling adopted has not put any herd-type in an unfair position so far as type of farm and standard of land exploitation are concerned. If any herd-type is penalized through unproductive area it is that having a high milk-test, as a study of the individual farms shows that those having a high percentage of non-exploited land are slightly more prevalent in those groups where test is comparatively high. The same farm data can therefore be used to show quite impartially the economic position of production based on variation in the percentage butterfat content of milk. The test range for the farms under discussion is from 3·5 to 5·4 per cent., and therefore covers all types of cows within reasonable limits. Under herd-testing conditions, the average test for the 967 farms is 4·57 per cent. When this is realized, and the distribution of farms within the test groups as shown in Table 4 is studied, it will be appreciated that advocacy of the production advantages accompanying high test is not a revolutionary suggestion, but merely a substantiation of this policy being adopted by the majority of farmers in ordinary management.

The percentage distribution of these farms within the test range suggests that members of herd-testing associations—in the North Island

Table 4.—Farms grouped according to Average Test of Butterfat Content of Milk (Unweighted Averages).

Milk Test Range.	Number of Farms.	Percentage of Farms in Groups.	Average Number of Cows.	Average Size of Farms.	Average Test.	Average Butterfat per Cow.	Average Milk per Cow.	Average Cows per 100 Acres.	Average Butterfat per Acre.	Average Milk per Acre.
Per Cent.				Acres.	Per Cent	lb.	lb.		lb.	lb.
3·5–3·8 ..	50	5·17	57	170	3·69	240	6,472	36·7	88·0	2,382
3·9–4·2 ..	155	16·03	59	162	4·09	247	6,033	39·1	96·9	2,366
4·3–4·6 ..	333	34·44	53	139	4·47	260	5,816	41·3	108·4	2,417
4·7–5·0 ..	332	34·33	52	135	4·83	280	5,809	43·3	122·1	2,540
5·1–5·4 ..	97	10·03	54	133	5·21	302	5,791	43·2	131·3	2,514

at least—are knowingly or unknowingly raising the average test of their herds. The average test for all milk delivered at cheese-factories is in the vicinity of 4·1 per cent., but unfortunately a similar figure for the whole factory supply is not procurable under home separation for butter-factories. It is probable, however, that if the figure were procurable it would be found that the average for all herds would be higher than that registered in cheese-factories alone.

When herds or farms are grouped in this way the milk-production capacity of low-test herds becomes apparent, even under average farm conditions. The range of variation registered is not great, however, the increased butterfat content of the reduced bulk of milk still giving a material advantage in average butterfat production per herd. This, combined with a greater density of milking cows on farms running high-test herds, results in a wide variation in unit-area production of butterfat over the range of test groups. This increase in butterfat production is accompanied by a slightly increased output of milk per acre also. The flattening tendency shown in carrying-capacity and yield per acre for the last group is due to an unusual proportion of unproductive land on some of the farms, which penalizes the group unduly in comparison with those of lower average test. Carrying-capacity should have been in the vicinity of 46 cows per 100 acres.

It has been mentioned previously that test (and its accompanying conditions) is the most stable factor influencing the standard of butterfat output, as it cannot be affected to any marked degree by ordinary management variation on commercial dairy-farms. (There is another factor which is to a great extent associated with test—namely, body weight—but this has been excluded owing to lack of detailed information. Its importance will be discussed at a later stage.)

It is a well-known fact that herd-test does vary from day to day, the chief causes of variation being of a physiological nature. Excellent examples of this daily variation are to be found in Veale's records of three Taranaki herds studied during the season 1926–27, to establish a comparison between high- and low-test milks for cheesemaking. This does not, however, detract from the statement that test is the factor most removed from the influence of the farmer in his ordinary course of management. In view of this fact, and having established the close correlation of test with yields of butterfat and milk, both on a per-cow

average improvement of this dimension naturally means a far greater increase in income from those farms in the low-test groups, the extreme range being over 50 per cent. in the case of individual farms.

The position as discussed shows the advantage to be derived by raising the test over a group of herds averaging 4·57 per cent. to a uniform level of 5·21 per cent. of butterfat in the milk. As previously mentioned, the test generally accepted as the average for all herds in the Dominion is about 4·1 per cent., which corresponds with a production of 97 lb. of butterfat per acre. If this is the true average position, then the raising of the general level to an extreme point of 5·21 per cent. would result in an increased output of over 35 per cent. of butterfat. This would represent a corresponding addition to the total pay-out of farmers at any price-level, and also in trading power to the State. It is necessary to keep this point in mind during this and subsequent discussions.

This increase in per-acre receipts can be also interpreted as volume output of butterfat, and it is in this connection that the national aspect assumes great importance. It is contended that the sample of farms treated in this analysis is of sufficient size and variety in type to allow of the assertion that the movement in per-acre production shown in Table 4 is due practically wholly to variation in test and the conditions accompanying this variation. It can therefore be said that by an adjustment of organization in the direction of herds of high average test, the volume of butterfat output could be increased by at least 17 per cent., but probably as much as 35 per cent., without any material alteration in the standard of general farm and herd management. The total estimated weight of butterfat produced in the season 1930–31 was 322,000,000 lb. Assuming an increase of only 17 per cent. on this total, the increased output would represent over 54,000,000 lb., all of which would be available for export, as such a readjustment would not entail a greater internal usage of whole milk or milk products. This would equal a 22 per cent. increase on butterfat at present exported in the form of butter and cheese. The question as to the form in which any such increase should be exported need not be discussed at the present time, but it is apparent that our trading power must be considerably enhanced by an increase in output as mentioned above.

TEST AND ITS RELATION TO CHEESE.

Any concerted action aiming at the immediate improvement in the financial position of farmers through raising the test may be met by the argument that high-test milk is not so suitable for cheese manufacture. It is not intended to enter into a discussion of the technical points of manufacture involved, but it is desirable to mention that Veale's experiments of 1926–27 showed that the average quality of the products of high- and low-test milk was equal. They all had defects or virtues at different times of the season, but, on the whole, high-test milk supplied a cheese which, if anything, received a higher average valuation in London than did that from low-test varieties. This being the case, the economics of test variation come back to the farm itself.

The relationship of test to high unit-area output clearly illustrates the advantages to be obtained by the exploitation of a high-test herd, irrespective of the nature of the factory supplied. It has been argued

that pay-out on a butterfat basis at a cheese-factory penalizes the owner of low-test herds, owing to the greater amount of cheese per pound of butterfat obtained from low-test milk. It is claimed that a differential payment should therefore be made in accordance with the variation in cheese yield of milks with different fat contents. Veale, in Bulletin No. 9, N.Z. Department of Scientific and Industrial Research, when dealing with this question, states that the value for cheesemaking of milks testing 3·55, 3·85, and 4·75 per cent., should be 17·687d., 16·548d., and 15·335d. per pound of butterfat respectively for the season concerned. These pay-out values are based on the products from three herds having average tests as quoted above. For our present purpose these values can be accepted without going into the variations in manufacturing costs which are undoubtedly associated with the handling of greater weights of low-test milk required to produce a given quantity of cheese.

In Veale's discussion all milks were debited with a flat charge of 3·75d. per pound of butterfat to cover costs of manufacture and charges up to f.o.b. It is probable that investigation would reveal that the variation in costs in this and other directions for different test milks would to some extent offset the difference in yield on a fat basis. Accepting these values in the meantime, it is illuminating to plot the three herd-records used by Veale, against the production curve for the 967 herds embodied in the present analysis. This is done in the accompanying graph. It will be seen that the production curve is based on per-acre output for different test groups as found in Table 4. The point at which Veale's three herds strike the production curve is determined by the projection of a straight line from the base-line of test range, at that point which corresponds with the average for the respective herds dealt with. It is not suggested that the actual per-acre production for these three farms was exactly the figure indicated by this method. It is contended, however, that the herds embraced in this production curve are sufficiently representative of their test group to ensure that herds of any particular test are likely to give on the average a per-acre output corresponding with the curve shown within a reasonable margin of error. On this assumption it will be found that Farm 1, with an average herd-test of 3·55 per cent., coincides with a per-acre production of 86 lb.; Farm 2, with an average herd-test of 3·85 per cent., 91 lb.; and Farm 3, with an average herd-test of 4·75 per cent., 119·5 lb. per acre. If the values of these productions are computed at the prices previously discussed and assessed by Veale, it will be found that the respective per-acre returns are as follows:—

Table 7.—Probable Average per-Acre Production of Farms with Tests as used by Veale, and Pay-out on his Butterfat Valuation.

Average Herd-test.	Estimated per-Acre Production.	Total Pay-out per Acre at 17·687d. per Pound.	Total Pay-out per Acre at 16·548d. per Pound.	Total Pay-out per Acre at 15·335d. per Pound.	Index of Pay-out.
Per Cent.	lb.	£ s. d.	£ s. d.	£ s. d.	
3·55 ..	86·0	6 6 9	..	..	100
3·85 ..	91·0	..	6 5 6	..	99
4·75 ..	119·5	..	..	7 12 9	121

average improvement of this dimension naturally means a far greater increase in income from those farms in the low-test groups, the extreme range being over 50 per cent. in the case of individual farms.

The position as discussed shows the advantage to be derived by raising the test over a group of herds averaging 4·57 per cent. to a uniform level of 5·21 per cent. of butterfat in the milk. As previously mentioned, the test generally accepted as the average for all herds in the Dominion is about 4·1 per cent., which corresponds with a production of 97 lb. of butterfat per acre. If this is the true average position, then the raising of the general level to an extreme point of 5·21 per cent. would result in an increased output of over 35 per cent. of butterfat. This would represent a corresponding addition to the total pay-out of farmers at any price-level, and also in trading power to the State. It is necessary to keep this point in mind during this and subsequent discussions.

This increase in per-acre receipts can be also interpreted as volume output of butterfat, and it is in this connection that the national aspect assumes great importance. It is contended that the sample of farms treated in this analysis is of sufficient size and variety in type to allow of the assertion that the movement in per-acre production shown in Table 4 is due practically wholly to variation in test and the conditions accompanying this variation. It can therefore be said that by an adjustment of organization in the direction of herds of high average test, the volume of butterfat output could be increased by at least 17 per cent., but probably as much as 35 per cent., without any material alteration in the standard of general farm and herd management. The total estimated weight of butterfat produced in the season 1930–31 was 322,000,000 lb. Assuming an increase of only 17 per cent. on this total, the increased output would represent over 54,000,000 lb., all of which would be available for export, as such a readjustment would not entail a greater internal usage of whole milk or milk products. This would equal a 22 per cent. increase on butterfat at present exported in the form of butter and cheese. The question as to the form in which any such increase should be exported need not be discussed at the present time, but it is apparent that our trading power must be considerably enhanced by an increase in output as mentioned above.

TEST AND ITS RELATION TO CHEESE.

Any concerted action aiming at the immediate improvement in the financial position of farmers through raising the test may be met by the argument that high-test milk is not so suitable for cheese manufacture. It is not intended to enter into a discussion of the technical points of manufacture involved, but it is desirable to mention that Veale's experiments of 1926–27 showed that the average quality of the products of high- and low-test milk was equal. They all had defects or virtues at different times of the season, but, on the whole, high-test milk supplied a cheese which, if anything, received a higher average valuation in London than did that from low-test varieties. This being the case, the economics of test variation come back to the farm itself.

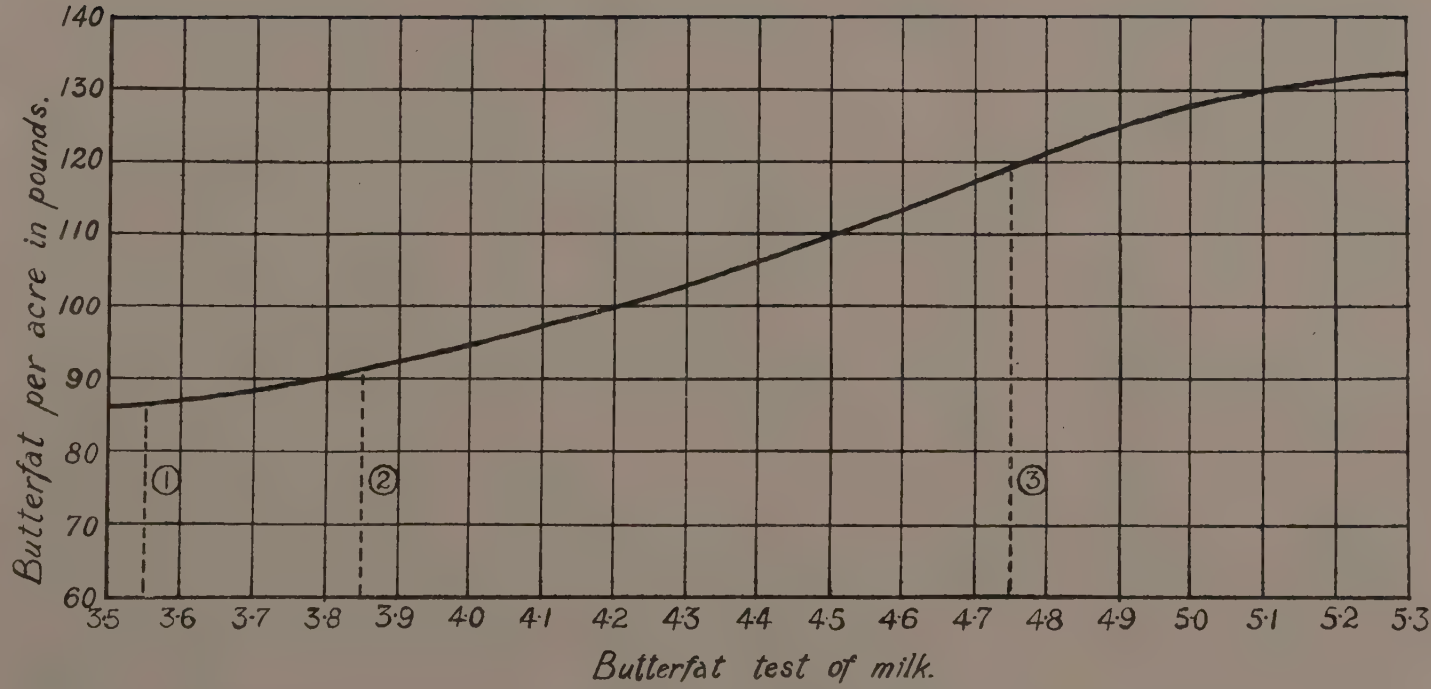
The relationship of test to high unit-area output clearly illustrates the advantages to be obtained by the exploitation of a high-test herd, irrespective of the nature of the factory supplied. It has been argued

that pay-out on a butterfat basis at a cheese-factory penalizes the owner of low-test herds, owing to the greater amount of cheese per pound of butterfat obtained from low-test milk. It is claimed that a differential payment should therefore be made in accordance with the variation in cheese yield of milks with different fat contents. Veale, in Bulletin No. 9, N.Z. Department of Scientific and Industrial Research, when dealing with this question, states that the value for cheesemaking of milks testing 3·55, 3·85, and 4·75 per cent., should be 17·687d., 16·548d., and 15·335d. per pound of butterfat respectively for the season concerned. These pay-out values are based on the products from three herds having average tests as quoted above. For our present purpose these values can be accepted without going into the variations in manufacturing costs which are undoubtedly associated with the handling of greater weights of low-test milk required to produce a given quantity of cheese.

In Veale's discussion all milks were debited with a flat charge of 3·75d. per pound of butterfat to cover costs of manufacture and charges up to f.o.b. It is probable that investigation would reveal that the variation in costs in this and other directions for different test milks would to some extent offset the difference in yield on a fat basis. Accepting these values in the meantime, it is illuminating to plot the three herd-records used by Veale, against the production curve for the 967 herds embodied in the present analysis. This is done in the accompanying graph. It will be seen that the production curve is based on per-acre output for different test groups as found in Table 4. The point at which Veale's three herds strike the production curve is determined by the projection of a straight line from the base-line of test range, at that point which corresponds with the average for the respective herds dealt with. It is not suggested that the actual per-acre production for these three farms was exactly the figure indicated by this method. It is contended, however, that the herds embraced in this production curve are sufficiently representative of their test group to ensure that herds of any particular test are likely to give on the average a per-acre output corresponding with the curve shown within a reasonable margin of error. On this assumption it will be found that Farm 1, with an average herd-test of 3·55 per cent., coincides with a per-acre production of 86 lb.; Farm 2, with an average herd-test of 3·85 per cent., 91 lb.; and Farm 3, with an average herd-test of 4·75 per cent., 119·5 lb. per acre. If the values of these productions are computed at the prices previously discussed and assessed by Veale, it will be found that the respective per-acre returns are as follows:—

Table 7.—Probable Average per-Acre Production of Farms with Tests as used by Veale, and Pay-out on his Butterfat Valuation.

Average Herd-test.	Estimated per-Acre Production.	Total Pay-out per Acre at			Index of Pay-out.
		17·687d. per Pound.	16·548d. per Pound.	15·335d. per Pound.	
Per Cent.	lb.	£ s. d.	£ s. d.	£ s. d.	
3·55 ..	86·0	6 6 9	..	..	100
3·85 ..	91·0	..	6 5 6	..	99
4·75 ..	119·5	..	..	7 12 9	121



GRAPH SHOWING CORRELATION OF BUTTERFAT PRODUCTION PER ACRE WITH VARIATION IN MILK TEST.

The vertical dotted lines, numbered 1, 2, and 3 respectively, represent the three herds referred to in the text (see preceding page).

To obviate any misconception on the part of individual farmers, it must be reiterated that the production position for herds of different tests, as indicated above, may not coincide with the per-acre production standard of single farms carrying herds conforming to such test standards. It is contended, however, that if groups of farms carrying such herds are studied as groups, the law of averages will ensure that average unit-area production for any group will conform closely to the standard production curve given, which is based on test variation. Although individual farms are treated in this instance, they are examples only, and should not be looked upon as individual units, but rather as representative of the average of all farms carrying herds of the type giving the milk-test prescribed. If this precaution is observed it will be seen that, even on a reduced pay-out for butterfat contained in high-test milk, the respective farmer's position is likely to vary by 21 per cent. on an average run of farms carrying herds conforming to this range of test, the advantage still being in favour of those farms milking a herd and supplying milk with a high butterfat content.

What is the practical application of the facts under discussion with reference to milk test? It has been proved beyond question that under average farm conditions, where farm type and management are as nearly equal as it is possible to arrange them, test variation and the conditions accompanying such variation are responsible for a very decided increase in output of butterfat per unit of area farmed.

The financial return to farmers supplying factories is in direct proportion to the per-acre increase obtained in butterfat production, when pay-out is based on butterfat supplied. This must always be so in the case of suppliers of butter-factories, and before any alteration can be made in the case of milk for cheesemaking it is apparent that very thorough investigation must be made to substantiate the need for and fairness of any differential payment for high- or low-test milk. The problem in relation to cheese-factory supply has two distinct aspects—namely, the economics of butterfat production on the farm and the economics of manufacturing and marketing of the finished product. This work has never been done comprehensively, and undoubtedly should be carried out under strictly controlled conditions and over a long enough period, so that the advantages and disadvantages of a mixed supply of milk of different tests may be finally established. Enough has been said, however, to show that when the financial position is studied on a pay-out basis which forms the most adverse comparative data available for milks of different tests, high-test herds will on the average give the farmer a better per-acre return, no matter what type of factory is supplied. The other fact, which cannot be too strongly stressed, is the effect of increase in unit-area production on farm production costs per unit of output.

As has been suggested previously, organization and management of the dairy-farms of New Zealand has been consciously or unconsciously moving in the direction of the building-up of herds calculated to give milk of higher test. From the viewpoint of economy in production and total volume of the Dominion's output this movement is undoubtedly sound. The pursuance of such a policy will raise problems to be overcome in the conversion of high-test milk into cheese, but it seems apparent that the advantages to be gained from increased output

are such that it is factory technique which must be altered to suit the supply rather than the supply altered to suit existing technique.

MARKETING QUESTIONS.

The total volume of butterfat produced in the Dominion during the season 1930–31 slightly exceeded 322,000,000 lb. Of this total 211,500,000 lb. was represented by butter manufactured, and 75,500,000 lb. by cheese. Although cheese does not approach butter in the amount of butterfat used in its manufacture, it is essential that the volume of cheese should be at least maintained. This becomes very apparent when it is remembered that New Zealand holds the key position in the import cheese markets of Britain, being responsible for approximately 60 per cent. of the total imports. The position we occupy in the supply of cheese is relatively much stronger than for butter, and it is imperative that this be maintained. The tendency is for surplus butterfat from all exporting countries to be exported to Great Britain in the form of butter. The relative strength of the market for butter and cheese reflects this to some extent, in so far as the price ratio between the two commodities is in favour of cheese and has been for some time past. The 15 per cent. of Britain's imported cheese supply which is derived from countries other than Canada and New Zealand is mainly of foreign origin. It is difficult to foresee what may happen to this supply under altered tariff conditions, but, whatever the movement may be, New Zealand should gain if she is in a position to make up any deficiency in supply occasioned through Britain's preference policy. The level of cheese consumption is comparatively stable in Great Britain, but it appears that consumption of butter can be stimulated by the supply of high-grade produce at attractive prices.

Unless the spending power of those classes of the British consumer on whom we depend is materially increased, the whole of our efforts should therefore be towards an increased supply of produce at a price which ensures maximum and rapid consumption, rather than an effort to raise prices under artificial conditions. Although the butter consumptive capacity of Great Britain has proved extremely elastic, the rate of increase registered of recent years cannot be expected to continue, particularly at higher prices. It seems that increased absorption must take place through displacement of other products. If this is materially true, then the object of our farm organization and management must be towards the production of butterfat at a lower price for some years to come, which will necessitate reorganization of existing conditions to allow of a balance between production costs and realized prices.

FULL EXPLOITATION OF DAIRY HERDS.

To facilitate such a position it is necessary that immediate plans be made to produce more stock food of improved quality. Coincident with the execution of such a plan, a breeding replacement policy should be pursued which will ensure that replacement stock is of a type calculated to raise herd averages, and at the same time allow of the widest possible ratio between the percentage of food consumed to maintain body condition and that which is converted directly into milk. In other words,

replacement stock should be kept strictly from cows producing above the herd average. In addition, replacement stock should be the progeny of animals so selected that the average herd-test will be raised and a maximum density of cows carried per unit of area farmed.

To allow of such a policy being exploited to its fullest extent it is essential that all dairy cows in the Dominion (at least those supplying dairy factories) should be tested annually. The degree of accuracy desired should be such that reasonably sound methods may be used in breeding and culling. Before such a scheme can be put fully into operation it is necessary that methods of testing be investigated which will give a reasonable degree of accuracy at a low cost. In anticipation of such a movement, and to facilitate the further study of the effect of stock types on unit-area production, it is imperative that all herd-testing records should include milk yields and test data, and that the total area of the farm and other land devoted to the dairy herd should be recorded.

To carry the investigation to a further stage it is necessary that research be conducted to determine the relationship of body weight to food consumption, milk yield, and average milk-test. This research would include measurements of static physical features, with the object of arriving at a method of determining body weight through one or two static conversion factors. Once this point has been reached, potential production under average farm conditions could be assessed with a reasonable degree of accuracy by a very limited number of testing periods.

In utilizing any such data for the culling and replacement programme due regard would be given to the correlation of body weight to carrying-capacity. It is apparent at the present time that light young heifers may be culled on butterfat records in favour of heavier animals, whereas if production per unit of body weight were taken into consideration the decision would be reversed.

These are points which may not appear very important to individual farmers, but when considered in the light of a far-reaching Dominion plan for the full exploitation of dairy herds and the land on which those herds graze, the aggregate advantages to be gained will be great.

Summary.

The position, so far as this analysis has been carried, may be summed up as follows:—

(1) Butterfat production per unit of area farmed is the final measurement of farm and herd organization and of efficiency in production management.

(2) When herd organization has been decided upon, butterfat production per unit of area and per cow can be varied over a wide range despite the potential capacity of the herd. This can be brought about by alterations in farm organization, and by the quantity and quality of food resulting from pasture management—always accepting that climatic conditions may modify the effects of such management.

(3) The percentage of butterfat contained in milk (milk test), and the amount of milk produced, are additional factors to be considered in herd organization. The effects of milk test and the conditions surrounding it have never previously been taken into consideration

in studying variations in unit-area production. It is apparent, however, that the economics of production are materially affected by such conditions, and as test variation from a static herd is virtually beyond the control of farm management, the test point at which a farmer is aiming should be carefully considered, and herd organization deliberately planned to bring about the desired results in as short a space of time as is possible.

(4) The most important factor influencing variation in unit-area production is cow density, or the number of cows milked per given area. As this is directly under the control of farm management once the herd type is fixed, it should be the first line of attack of all farmers in their efforts to increase output.

(5) The next most easily influenced factor is that of the butterfat average of the herd. Apart from the effect of food supply the potentiality of the herd is influenced each season by the standard of replacement of stock entering their lactation life. Therefore culling should be done on proved facts, and replacements made by heifers from proved cows. To ensure that even then the programme is a sound one, the potentiality of the herd sire and his ability to throw heifers of a production capacity above that of the dam should be firmly established.

(6) The two preceding features of herd and farm management are clearly understood and accepted by most farmers. The effect of test may not be so readily accepted, as alteration in cow types raises problems of assumption and sentiment. Its importance cannot be too strongly stressed, and wherever practicable should be fully considered. It is apparent that cow density and herd averages are influenced by body weight, by the standard of milk production, and by butterfat content of milk, and that these latter points must be taken into account when determining the efficiency of organization and management.

(7) The question of increased unit-area production, and consequently the total butterfat output of New Zealand, assumes a degree of importance under present conditions which warrants very drastic measures to ensure that the greatest possible benefits shall be derived by individual farmers, and that the trading power of the State is enhanced to the extent which it has a right to expect from the farms of the Dominion.

Acknowledgment is made of the co-operation of Mr. W. N. Paton, Farm Economics Section, in the preparation of this article. It is proposed to publish shortly a further article, dealing with relevant statistical correlations, by Mr. Paton.

Lambs fattened on Linseed.—The Instructor in Agriculture for Hawke's Bay reported that last season a Fernhill farmer had a few bushels of linseed on hand, and sowed this with his rape. The rape was poor owing to the dry season, and when ready to feed off he turned on 600 lambs. For the first ten days they did not touch the rape but fed off the linseed and did remarkably well. When the linseed was finished they only then reluctantly took to the rape. At the end of ten days this farmer sent 304 lambs away fat; the remainder took about fourteen days more to reach condition on rape.

NEW ZEALAND PASTURE SEEDS.

WHAT THE DOMINION HAS TO OFFER.

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Introduction.

ECONOMIC development of the Empire calls for specialization and exploitation to the fullest of all natural resources at its members' disposal. New Zealand's speciality is grass, and its great natural resource is climate. Roundly, 94 per cent. of the exportable products from New Zealand are derived from grassland. All-the-year grazing, supplemented by hay and silage derived from pasture, are the arresting features of New Zealand grass-farming.

Seed-production as a phase in grassland farming is essentially sound. In a land dominantly grass, periods of high production (spring) alternate with periods of low production (winter). Whereas under stocking conditions alone that balance between winter production and spring production is difficult to secure, and can only be balanced and levelled up by the preservation of certain spring and early summer growth, as hay or silage, or by the growing of special supplementary crops such as roots, the production of seed—which means closing up certain portions of the farms during the peak period of growth—aids materially in stocking the farm so that less disparity exists between the low winter-carrying period and the high spring-carrying period.

Specialization means an ever-improving quality in the article produced. Any serious attempt to improve the productive, lasting, or disease-resistant qualities of the more important pasture plants calls in the end stages for an organization that will see to the production and perpetuation on a commercial basis of those proven types that are the outcome of natural selection or intensive breeding. Any breeding-work in pasture plants, any effort to improve species production, type-persistency, &c., is from the economic aspect doomed to failure without some system of seed certification.

Seed-production from the old-established permanent grasslands is now well in hand in New Zealand under a Government certification plan whereby the strain of seeds produced is of a guaranteed permanent-pasture type.

STRAIN IN PASTURE PLANTS.

The significance of strain in pasture plants is rapidly becoming recognized throughout the world, and it is not overmuch to prophesy that within a few years the pasture-seed trade of the world will be based on pedigree and type. A few words on strain development will serve to show the significance of strain and pedigree in pasture plants. The evolution of species in response to, and their perpetuation in harmony with, the forces of the habitat or growing-place has general acceptation. Hybridization, mutations, &c., have doubtless played a part in the initiation of change in a species, but after such change has been initiated the forces at work in the habitat will decide whether that change will become effective or not. Man in his agriculture throughout the world

has taken up the wild species at a certain point in their evolution, and has applied them in a variety of ways. New habitats have been created, and just as species evolved in response to the call of the habitat under wild conditions, so to-day we can recognize strain in species evolved to suit altered habitats under cultivation. The more widely and variously used the species, the greater the significance attachable to strain within those species.

Perennial rye-grass, cocksfoot, white clover, and red clover, for example, are widely exploited in grasslands in virtually all parts of the world. Each district and each country, according to soil and climate, have used these species in roughly four different ways: (1) For truly permanent pasture that remains down for a long period of years; (2) for short-rotation pastures that are ploughed every two to four years; (3) for strictly temporary pastures that last only one to two years; and (4) for seed-production purposes under any one of these categories.

From our researches up to the present one may say that different strains of herbage plants have developed according to the farming system practised. The old permanent pastures hold, with certain exceptions, to the permanent strain. The short rotation areas have evolved a short-lived type; the arable and annual cropping areas have run distinctly to an annual type. Crops grown specifically for seed have evolved towards stemmy, high seed-yielding types. The cold-winter countries have produced winter-dormant forms. Periodic droughts have produced scant herbage, stemmy, quick-maturing, short-lived forms, and the mild-winter countries have produced winter-growing forms. The permanently grassed, high-production soil-types have produced high-production forms, and the low-production, permanently grassed soils have produced low-production types.

Strains of herbage plants cannot be evolved at a moment's notice, nor yet by years of careful breeding in the nursery under non-pasture conditions. Time is an essential factor during which are brought to bear habitat forces that mould and ultimately fix definite and specific characters. Such characteristics hold to a type until such time as further new habitat forces gradually modify and evolve a type more perfectly attuned to the new environment. Just as the first process involves time as an agent, so modification of an evolved definite type requires time. For example, mother-seed rye-grass of the Hawke's Bay type taken to Canterbury, Australia, or England will remain true to type for many years, and the progeny of that rye-grass would be true to type until such a time had elapsed that the new environment in Canterbury, Australia, or England had made itself felt. Leaving out of consideration the factor of cross-pollination by Italian rye-grass or false perennial forms, it is hard to imagine much change in the type within, say, ten to twenty years, provided the area remains in permanent pasture. Under arable farming, where the crop is sown and seeded and that resultant crop sown and seeded year after year, change in type may come about in less than ten years.

Some Examples of Type Evolution in response to Habitat Conditions.

There are now in New Zealand certain high-production permanent grasslands over sixty years old. These presumably were originally sown with good types of English perennial rye-grass, cocksfoot, and

FIG. 1. PIECE OF TYPICAL NEW ZEALAND FIRST-CLASS PASTURE SWARD.

The highly productive, highly competitive, long-seasonal-growth sward characteristic of the high fertility habitats in New Zealand, which have in themselves by automatic culling and selection evolved high-production strains of pasture-plants, seed of which is now being offered under the Government certification system.

white clover, but under more favourable climatic and soil conditions in New Zealand than in the land of their origin new specific types have been evolved, characterized by high production, high persistency, and long seasonal growth. It seems sound to accept these areas as constituting mother-seed production areas, and to expect that the progeny from these areas will hold to the type, for some years at least, under any habitat in the world where the soil and climate are suitable for the production of pasture.

Kentish wild white clover is the product of a relatively stable habitat characterized by moderately high-fertility soil, not overintense competition from taller-growing grasses, a product of the grazed pasture rather than hay or silage pasture, and in an area of moderately long dormant winter period. This type, on being transferred to a similar habitat in New Zealand, behaves identically to Kentish wild white clover in England. If, however, it is sown out on high-production, and particularly high-winter-production, grassland soil in New Zealand it is swamped by the intense competition. Again, if normal Kentish wild white has been sown under a gradually improving habitat, such as has probably occurred in New Zealand, it is safe to assume that out of Kentish wild white have been eliminated by competition effects all the lower-producing and winter-dormant types, and there has been gradually evolved a higher-producing strain, and from this a still higher-producing strain, until we have the high-producing, tall-growing, dense-foliaged, long-seasonal-growth strain of white clover characteristic of the highest production habitats found in New Zealand to-day. Areas of white clover of this type in New Zealand are now being located and registered under a certification plan as mother-seed areas.

Danish cocksfoot is another case in point. This is a type that has been evolved to produce seed under a habitat condition as far as climate is concerned too cold in the winter for sustained growth of cocksfoot. Danish cocksfoot sown in New Zealand still retains its sigh seed-production characteristics, and at the first frost burns badly and remains more or less winter dormant until the early spring, when a crop of flowering stalks is produced at the expense of foliage.

Similarly, strains of red clover and lucerne from Canada, Russia, Sweden, Austria, and Germany are winter dormant in New Zealand, probably for as long as they are in the country of origin. Montgomery red clover from Great Britain, however, is not so winter dormant, and this again is in conformity with the conception of characteristics inbred by habitat conditions. Montgomery red clover in New Zealand is as distinct from broad red clover when grown here as it is in England, and this irrespective of the soil conditions under which it is sown. Montgomery red, however, grown for, say, thirty years under high-productive and therefore highly competitive associations in New Zealand may develop into a uniformly higher-production type than the normal type produced under conditions as they exist in Montgomeryshire.

Further, British indigenous cocksfoot and the British indigenous rye-grass are both finer in the leaf, more dense but notably lower-producing under sward conditions, than the New Zealand cocksfoot or New Zealand rye-grass, and there is a danger if these were sown under high-production conditions in New Zealand that they would be swamped by rank volunteer growth such as Yorkshire fog, New Zealand white clover, or New Zealand rye-grass. Under moderately low-fertility

habitat conditions, however, British indigenous selections of cocksfoot and rye-grass are identical in New Zealand with those seen growing in the trial grounds at Aberystwyth in Wales.

Again, annually inclined types of herbage plants, which are largely the product of arable farming, behave in New Zealand identically with the same type grown in Great Britain, Europe, Australia, or elsewhere. Thus Dutch white clover behaves as an annual in New Zealand just as it does in Great Britain. Lombardy red clover and the Italian types of red clover are short-lived in England; they are the shortest lived red clovers yet tested in New Zealand, and this irrespective of the soil-type on which they are sown. Years of arable farming and of short rotation have left their mark on strain, just as years of permanent-grass-farming have left their mark; only in the first case annual types have been evolved, and the more arable the farming practice adopted the more truly annual the type. Short-rotation systems of farming have evolved the false perennial rye-grass types, the broad red clover types, and short-lived white clover types. In Australia Wimmera rye-grass is replacing in certain districts the somewhat later-maturing and longer-lived Italian rye-grass, and drought areas there have evolved their own peculiar types to harmonize with the short production periods between those of intense drought. Wimmera rye-grass, drooping clover, and quick maturing forms of subterranean clover may be regarded as types specially evolved by the drought habitats of Australia.

Changes in pasture-plant types such as cited have not come about in a year. Probably some thirty to forty years are required to change the type by habitat conditions alone. The plant-breeder and selector, working within definite and recognizable habitats, may introduce into commerce improved strains dominantly of the one type long in advance of what can be done by natural selection alone. Where it may take ten years or more for a certain inferior type to be eliminated under natural conditions, the plant-breeder by selection and culling may perform the same operation in considerably less time.

Recognizing the great part the habitat plays, however, what a wealth there is in the old pastures where high production and consequently high competition have ruled for sixty to eighty years. High production and consequently high competition are specifically stipulated for the reason that where soil fertility is low and consequently production is low there is room for low-production, free-seeding annual types to perpetuate themselves by reseeding. Similarly on heavy land where there is winter poaching, or where pastures are opened up in the autumn by drought or overhard grazing, conditions for reseeding are propitious and annual types may persist for many years by reseeding. In New Zealand Italian rye-grass is quite dominant on certain high-production country that has not been ploughed or sown for over thirty years. This is by reseeding, and for the most part these are pastures that have never been sown down with good perennial strains. Although, however, age of pasture alone is no guarantee of type, nevertheless it is to the old pasture, under inspection, trial, and certification, that we must go to get our mother-seed supplies as a nucleus for increase seed growing. The point it is specially wished to stress is that the best strains showing high production, long seasonal growth, and high persistency are to be found in the highly competitive grazing pastures of the world.

New Zealand, with its equable climate, high soil-fertility (natural, or induced by top-dressing), and its system of all-the-year-round grazing, has evolved a type or types that are going to prove invaluable to the grasslands of the Empire. Just as winter dormancy persists in a strain that has been evolved under cold climatic conditions irrespective of the country wherein the progeny of those types is sown, so also should non-winter dormancy hold to a certain extent, for some years at least, even though the strain evolved under milder winter conditions is sown under slightly more rigorous winter conditions. Temperature, of course, is a very limiting factor to growth irrespective of country and type, and there is probably a greater danger of non-winter dormant strains being winter killed than in the case of the markedly winter-dormant forms. It is certain, however, that winter-dormant types are of no value to a country where the winters are mild, and as a general practice it would appear sound that an importing country should look for its supplies of perennial pasture seeds from a good permanent-grassland country as mild or of somewhat milder winters than its own. Great Britain, therefore, should import its pasture-seed requirement from New Zealand or from the coastal areas of Australia rather than from Canada, America, or Europe.

Value of High Production in a Strain.

High production in a strain offers greater scope to the grassland farmer. A low-production strain, as with a low-production species, cannot respond to liberal treatment, and therefore a limit is set to what the farmer can accomplish by manuring, harrowing, drainage, and other aids to growth. He is limited by the potentialities of his species or strain. In New Zealand much work has been done on the grassland successions that arise as a result of alterations in the conditions of the habitat. Low fertility soils in New Zealand carry a sward of danthonia, hair-grass, sweet vernal, bay-grass, suckling clover, clustered clover, haresfoot trefoil, and the like; or brown-top may be quite dominant on colder, stiffer, and wetter soils. These pastures almost invariably carry a small percentage of white clover, cocksfoot, crested dogstail, Yorkshire fog, Poa pratensis, and rye-grass. If such a sward is systematically top-dressed and harrowed a change in the pasture association comes about. The lowest producers are the first to go; then the group a little higher in production, until finally there comes to exist a dominant rye-grass, white clover, and cocksfoot sward. This change is made possible through the inherent higher production capabilities of the rye-grass, cocksfoot, and white clover; and if, for example, we have a rye-grass of a low-production type that had a production capacity equal only to, say, brown-top, then it would be impossible to replace that brown-top by rye-grass, nor would there be much advantage in doing so. Under improved pasture conditions, therefore, where the aim of the farmer is high and still higher per-acre production, the value of inherently high-producing strains is easily realized.

In the grasslands of the world, of course, there is a place for low-production species where it is impossible to give cultural and manurial aids to the pasture. In New Zealand Danthonia pilosa, brown-top, Yorkshire fog, ratstail, suckling clover, Lotus major, clustered clover, &c., have their place, and these as climax associations represent the inherent possibilities for production that a soil growing them is capable of producing in its present state. A high-producing rye-grass would starve on

such a soil-type, and it is a moot point whether it is worth while breeding a low-production rye-grass that would fit naturally and blend in with the other dominants of such a sward.

Similarly, it is probably not worth while to breed high-production strains of danthonia, brown-top, &c., when we have already other plants of inherently high-production capabilities. High production in any species is only possible under adequate feeding. Paspalum dilatatum is potentially an extremely high-production species, but in New Zealand it is high producing only on high-fertility soils. When paspalum is sown and farmed on low-fertility soils that in nature support only a danthonia-dominant sward, the paspalum, after having colonized the ground completely, does not produce as much green leaf as does the danthonia. New Zealand certified rye-grass will persist almost indefinitely on virtually any soil-type in New Zealand, but on dominant danthonia country or dominant brown-top country, unless top-dressed, it produces probably less than either of these, and it is not until the habitat conditions are improved that rye-grass shows superior to danthonia or brown-top. A low-production rye-grass sown on natural brown-top country would undoubtedly make a better permanent sward than would a high-production rye-grass on that same soil-type; but the point is, would it be much superior in production and carrying-capacity to the natural brown-top sward so easy to secure on that country?

The same applies to cocksfoot, red clover, and white clover. There are some extremely fine-leaved but low-production forms of cocksfoot within the British indigenous cocksfoot associations, and the surmise is that these forms would make a closer sward on low-fertility soils than would the broad-leaved, higher-producing types. Wild red clover from the Kent pastures represents a type inherent to low-fertility soils. Kentish wild red clover may do better on those low fertility habitats than any other forms of red clover, but one would not for a moment advocate wild red clover where the soil conditions were good enough to grow high-producing forms of Montgomery red clover.

Again, in Montgomery red clover there are innumerable forms, some at a glance almost indistinguishable from white clover, and certainly not more highly productive. Is there any point in selecting a red clover that is not more highly producing than white clover? Montgomery red clover is a splendid permanent-pasture or long-rotation pasture type, but selections that tend to be high producing rather than low producing should be the aim. New Zealand is now growing Montgomery red clover, and the possibilities are that under New Zealand conditions a high-producing type rather than a low-producing type will automatically become segregated out.

Kentish wild white clover is a comparatively low-producing type, and because there is no other permanent clover that is lower in production than Kentish wild white this type must ultimately find wide application in the sown grasslands of the world. The certified New Zealand white clover is a high-production type, and while it may not compete successfully with Kentish wild white on low-fertility soils, because of its higher soil-fertility demand, yet given high-production conditions New Zealand white clover will out-yield and replace Kentish wild white because of its natural inherent inbred high-producing characteristics.

Soil Fertility as a Factor in Choice of Strain.

Our choice of strain in pasture types is governed by soil and climate, or by the ability of the farmer to fertilize and otherwise improve the conditions for growth. Manurial responses and the return from the use of fertilizers are largely dependent on the strain of our herbage plants. In other words, the success of manurial applications in a sense is dependent on strain. High production is not possible from low-producing strains, however much manure is applied, nor is winter and early spring production possible from winter-dormant strains. New Zealand cocksfoot, therefore, should respond to manuring for out-of-season growth markedly better than Danish, Russian, Norwegian, or American. It will pay better to manure New Zealand certified rye-grass than any false perennial rye-grass, whether New Zealand grown or imported; and as far as the Agriculture Department's trials go up to the present it will pay better to manure New Zealand certified perennial rye-grass than any other perennial rye-grass yet tested. New Zealand white clover has the ability to produce out-of-season growth, and thus makes phosphate manuring for late autumn, winter, and early spring more profitable than with any other type of white clover.

(To be continued.)

PELLET AND LICK FEEDING OF STOCK.

B. C. Aston, Chief Chemist, and J. Lyons, Director of the Live-stock Division, Department of Agriculture.

The advantages of supplementary feeding of sheep in the three months of winter, during which the animals are either stationary in growth or are losing weight, are too obvious to be stressed. On typical sheep-country the land is usually hundreds of feet above sea-level, often inland in situation and exposed to wind, snow, and rain, the soil poor, and the short sweet pasture which is said to be typical of the food requirement of sheep is deficient, for in winter, when growth practically ceases, the sheep is forced to forage farther afield to obtain a ration deficient in quantity and quality, consisting of older growth.

During this period the animal probably cannot obtain the 3 lb. of dry matter a day which is held to be the normal requirement of each full-grown sheep, and much of the fodder it is lucky enough to get then is deficient in mineral matter. It is then that the animal is compelled to live partly on the body reserves which have been stored up during the periods of plenty—spring, summer, and autumn—through which it has passed. Several pounds of live-weight are therefore lost in the months of June, July, and August in those sheep which continue on pasture without the aid of supplementary feeding (roots, &c.), which on many runs it is not practicable to grow. The feeding of concentrated meal foods to sheep is quite possible, but the large outlay in cash is a decided objection in this period of low returns to the farmer.

Pellet-feeding is a method of feeding automatically both concentrated meal foods and mineral foods to sheep in one operation, without the need for special troughs or the necessity for rounding up the sheep to feed them. The meal foods—ground linseed, coconut (copra) from which

the excess of oil has been removed, and pea-meal (and there is no reason why fish- or meat-meal should not also be used)—are primarily designed to make the mineral part of the supplement attractive to sheep so that when the animal has learnt to eat the pellets it may continue to do so, the attraction being maintained by the nutrient meals added. These contain energy and fat-producing foods with a high degree of digestibility, and therefore in feeding mineral foods by this method the effect of the non-mineral concentrated foods, or the possible effect of suddenly stopping the use of such foods, may be overlooked. A flock of sheep grazing in winter on malnutrition country, on pasture to which ration is added a concentrated meal, may feel the stoppage of the supplement in the spring when the young growth is so different chemically from what they have been receiving.

It seems obvious that when compound pellets are fed to sheep in greater quantities than the bare amount necessary to secure a proper absorption of minerals the technique of the method requires to be studied. It should also be borne in mind that the market prices obtained by sheep-farmers at present hardly warrant the expenditure of £15 a ton on supplementary food of which a single sheep may eat several ounces per day. Assuming that they are given pellets which cost 3½d. per sheep weekly for the three months of winter it would cost 3s. 6d. for each sheep, but this could hardly be considered a practicable proceeding in the light of the present price of wool. The experience in Scotland by those who use this method is that pellets when properly made can be scattered on the ground, and the sheep have acquired such a liking for them that immediately the attendant appears in sight they muster themselves from the surrounding hills in an endeavour to obtain more than their share, but by scattering pellets judiciously on the ground the average consumption may be equal for all members of the flock. This experience has been duplicated in New Zealand. It has been found that when ultimately after some difficulty the sheep have been induced to take the pellets they become quite greedy for them and are willing to consume any amount that is put out at a given time. There is hence no wastage through non-consumption of mineral or meal food.

The giving of salt licks to stock is an admirable method of feeding minerals. The principal is that common salt, which is palatable and sought after by most grazing-stock, is a substance of undoubted value in maintaining the thriftiness or health of all vegetable-feeding animals, a fact which has been known since the very earliest times. The other minerals required are apparently not so attractive as common salt, and are not eaten to the same regular extent as the salt put before them. It has therefore become the practice to mix any mineral required with a large quantity of coarse or fine agricultural salt and feed it as a powder lick, or alternatively to put it out in the paddocks after pressing the ingredients into a brick or block in order to minimize the wastage by rain. Both methods are extensively practised. In the case of the powder lick it is necessary to have some box or trough protected from the weather, from which receptacle the lick may be fed. In this way such substances (presumed to be tasteless to animals as they are to human beings) as calcium phosphate, calcium carbonate, iron carbonate, iron oxide, charcoal, and sulphur are given mixed with salt. Some other mineral foods which are soluble and therefore presumably can be tasted

by the animals, and which are equally necessary, but are used in very much smaller quantities, are also mixed in with the salt lick. These are iodine administered as potassium iodide, magnesium sulphate (Epsom salts), sodium sulphate (Glauber salts). These presumably are not repulsive to the animal, although magnesium salts have a bitter taste to human beings.

It has been found in the cases of the bush-sickness region that it is undesirable to mix soluble iron salts in the lick for sheep. The particular soluble salt used was the double iron and ammonium citrate. Many formulæ have been published in which the use of ferrous sulphate is advocated, but how far this is attractive or nauseous to sheep has yet to be determined. The experiment with the double citrate certainly indicates that the taste might prevent sheep taking it. The iron sulphate, however, is useful perhaps in combating parasites, but for this purpose it would be more efficacious to administer the material to each animal as a bolus or drench. When iron is required in a lick as food-iron for continuous use it would be preferable to use finely ground limonite (hydrated oxide of iron) instead of the iron sulphate.

Now, although in the Dominions generally where sheep-farming is practised on a large scale there is no difficulty in getting sheep to take a salt lick, in New Zealand there are localities where farmers report that the animals will not take it, and this may possibly be due to the large amount of salt which is contained naturally in the pasture when this occurs in areas near the sea or liable to be affected by salt-laden gales from time to time. Whether the sheep in these districts can be induced to take salt licks containing other minerals is not known at present, but if it is ultimately found that there are large stretches of country deficient in some mineral where the animals will not take a salt lick the only remedy would be to give the minerals mixed with meal as in the pellet method, or with ordinary molasses in the case of cattle.

Comparing the three methods of giving mineral foods to stock (1) by pellet, (2) by salt-powder lick, (3) by salt brick or block :—

The pellet method of feeding is comparatively costly, requiring some patience to inaugurate on a run owing to the time taken to teach the animals to take the pellets, but when established as a practice there is no wastage due to weather and no expense is incurred in providing troughs for feeding.

The salt-powder lick is necessary at present when phosphates are used, as although much time and money has been spent by various organizations and by the Department of Agriculture in endeavouring to make a brick or block with phosphates which would stand up to transport and keep its shape in the field, this has not been achieved. In using a powder lick a trough or feeding-box is of course necessary, and the model shown elsewhere in this issue of the *Journal*, used by Mr. H. M. Besley, is recommended as cheap and efficient.

Block or brick licks of various sizes can easily be made where phosphates are absent from the mixture. These can be hung up to fences when small in size by means of a wire staple let into the brick, or may simply be thrown on the ground, the salt being so little soluble in block form that the loss from weather is negligible. In a subsequent issue of the *Journal* it is intended to discuss the composition of suitable licks for various districts.

ORCHARD SPRAYS IN NEW ZEALAND.

II. THE LIME-SULPHUR SERIES.

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ABOUT the year 1851 Grison, at Versailles, France, by boiling lime and sulphur together in water, produced a compound known as *eau Grison*, which was the forerunner of the spray so familiar to-day under the name of lime-sulphur. His material appears to have been used for a few seasons and then forgotten, since it was not until about 1881 that this spray again came into prominence, on this occasion being used in combination with salt against San Jose scale in California. The use of a combination of lime, salt, and sulphur was suggested in this connection, since it had proved successful shortly before in Australia against sheep-scab (Pierce, 1900, p. 49). In 1892 it was recommended as an insecticide in New Zealand (Hanlon, 1892). In experiments on the control of leaf-curl and scales of peaches Pierce (1900, p. 155) found that the salt was unnecessary, and so lime-sulphur in its present form came into use as a winter fungicide and insecticide.

Spray injury resulting from the use of bordeaux mixture against black-spot of apples led to the development of lime-sulphur as a summer spray by Cordley (1908) in Oregon, and its success in this connection led to its general adoption in New Zealand about the year 1912 (Campbell, 1916).

COMPOSITION OF LIME-SULPHUR.

This spray is prepared by boiling together in water measured quantities of lime and sulphur. The product, when filtered, is a clear reddish-amber liquid which chemically consists of calcium monosulphide, calcium polysulphides, calcium thiosulphate, and possibly small quantities of calcium sulphate. The amounts of these compounds vary according to the methods of preparation, the proportions of lime, sulphur, and water used, and the apparatus in which the material has been manufactured. As will be shown, the polysulphides alone possess fungicidal and insecticidal properties, consequently the worth of a lime-sulphur may be measured by the percentages of these ingredients present in solution.

UNIT OF MEASUREMENT.

In order that a given strength of spray may be applied at any specified time it is necessary that some unit be utilized for ascertaining the strength of the concentrated solution employed. For this purpose three methods have been used:—

(1) *Specific Gravity.*—Ever since lime-sulphur came into general use it has been customary to base dilutions on its specific gravity, readings being given generally in degrees on the Beaume hygrometer. That this is not a reliable indicator has been suggested by many, and demonstrated by Goodwin and Martin (1925), who showed experimentally that there was often no correlation between the specific gravity and the polysulphide content of the solution. Their work has been abundantly supported by the analyses conducted upon the lime-sulphurs used in New Zealand. As an example (one of many) it was

found that in two commercial lime-sulphurs with a specific gravity of Be. 33°, one had a polysulphide content of 11·92 per cent., the other a content of 18 per cent.

A second disadvantage of such a unit of measurement is that the specific gravity may be affected materially by the addition of foreign substances of no value as fungicides or insecticides. In one example of a local preparation analysed it was found that although the specific gravity was Be. 34° the polysulphide content was only 13·7 per cent., whereas another brand with a test of Be. 33° had a polysulphide content of 18 per cent.

(2) *Total Sulphur Content.*—In the United States of America it is customary to express analyses of lime-sulphurs in terms of the total sulphur content. But as Eyre, Salmon, and Wormald (1919), and Goodwin, Martin, and Salmon (1930) have shown, this is not an index of the fungicidal value of a lime-sulphur. These workers have shown, and this is confirmed by our numerous analyses, that the calcium thiosulphate and calcium monosulphide content of different brands varies considerably, and as these substances are not appreciably toxic to fungi and insects it is evident that the total sulphur content cannot be used as a basis of dilution.

(3) *Polysulphide Content.*—Tartar (1914) found that the insecticidal value and Horton and Salmon (1922) the fungicidal value of a lime-sulphur is dependent upon its polysulphide content, other ingredients present in solution being of no value at the concentrations present. According to Goodwin, Martin, and Salmon (1930) the concentration of the polysulphides is not affected by the type (being the same whether the polysulphide is in the lower or higher forms) nor by the base (ammonium, sodium, potassium, calcium, or barium) employed. Such being the case, it is evident that these compounds form a reliable guide to the dilutions at which any particular make should be employed. Goodwin (in Anonymous, 1926) stated that when a summer spray containing a 0·1 percentage of polysulphide was used it proved fungicidal to hop powdery-mildew. This figure corresponds with the percentage of these compounds present in summer dilutions of lime-sulphur tested during the past two seasons in New Zealand, and may therefore be used with safety as the unit for computing the different strengths to be applied according to the season of the year. Given the percentage of polysulphide present in any lime-sulphur, it is evident that from the table of dilutions supplied below an orchardist may arrive at the correct strengths at which to apply the diluted spray. Under the provisions of the Fungicides and Insecticides Act, 1927, it is proposed to draft regulations in such form that manufacturers will be required to place upon each container this percentage figure. In order that ambiguity may be avoided in the interpretation of this provision, it is advisable that the polysulphide percentages be determined by the modified Chapin method employed by Goodwin and Martin (1925), and given in percentages by weight (W/W).

Table of Dilutions.

Given the percentage polysulphide content of any lime-sulphur, the following table of dilutions should enable orchardists to apply each spray at the approximate strength recommended, irrespective of the brand used.

Polysulphide Content in Percentages W/W.*	Gallons of Water to be added to One Gallon of Concentrate to make a Spray of desired Strength: Sprays containing a Polysulphide Content of			
	1 per Cent.	0·2 per Cent.	0·1 per Cent.	0·083 per Cent
8	8	40	80	96
9	9	45	90	108
10	10	50	100	120
11	11	55	110	132
12	12	60	120	144
13	13	65	130	156
14	14	70	140	168
15	15	75	150	180
16	16	80	160	192
17	17	85	170	204
18	18	90	180	216
19	19	95	190	228
20	20	100	200	240

* Taken as referring to the nearest whole number: Thus 10·35 = 10 per cent., 10·60 = 11 per cent.

Reference to this table will show that the older expressions of 1–10, 1–50, 1–100, and 1–120 have no significance, since dilution is directly affected by the percentage of polysulphide in the concentrated solution. Consequently, ambiguity will be avoided if any given spray is referred to by its polysulphide content: Thus a spray containing 1 per cent. is recommended for application during the period between dormancy and bud-movement; 0·2 per cent. for from green-tip to pre-pink; 0·1 per cent. for summer applications; and 0·083 per cent. for autumnal applications on apple varieties liable to spray-burn, and for stone-fruits.

"Home-made" Lime-sulphur.

Numerous inquiries have been received from orchardists as to the best process to be followed in the preparation of "home-made" lime-sulphur. Before discussion is possible it is necessary to ascertain what is meant by the term "home-made." Our analyses have shown that the lime-sulphurs used in New Zealand fall into three groups, which may be defined by the polysulphide percentages present in the concentrate, and appear to exist in consequence of the process of manufacture employed.

Group 1: Lime-sulphurs of this group possess a high polysulphide content (16 to 19 per cent.), a low calcium thiosulphate content (under 1 per cent.), and are prepared by boiling under pressure in closed containers, consequently materials are not exposed to the air during preparation.

Group 2: These contain a moderate polysulphide content (10 to 13 per cent.), a high thiosulphate content (2·5 to 3·75 per cent.), and are prepared by the aid of steam heat in open vats exposed to the air.

Group 3: These contain a comparatively low polysulphide content (7 to 10 per cent.), a relatively high thiosulphate content (1·75 to 3 per cent.) and are prepared by boiling over open fires in vats exposed to the air.

To the third group belong "home-made" lime-sulphurs with which we are concerned. Their low polysulphide content is not in any way detrimental, since they will give comparable results in the field with more concentrated solutions, provided they are diluted according to the table given above. Analyses of eighteen batches of these home-made solutions show the polysulphide content to vary from 7 to 10 per cent., this variation being induced by differing proportions of lime, sulphur, and water used, and the different periods of boiling.

A survey of the literature shows that there exist considerable differences of opinion as to the proportions of lime, sulphur, and water to be used, and the length of time to boil. Such differences appear to have resulted largely from attempts to measure the value of the material by its specific gravity. It would appear that one of the most economical formulæ in use is that in which 100 lb. of sulphur and 50 lb. of lime are boiled for forty-five minutes with 50 gallons of water, as a concentrate is obtained which contains about 9 per cent. of polysulphides, and the waste sediment formed is not unduly large. Variation in the polysulphide content may be induced by altering the proportions of sulphur to lime, by increasing or decreasing the water content, by altering the time of boiling, or by using materials of varying degrees of purity. As it is desirable that sprays be applied at the dilutions recommended, orchardists preparing their own solutions are advised to avoid any alteration in the preparation of each batch, since variation in the polysulphide content may be caused by altering any of the factors mentioned.

The sediment formed during the preparation of lime-sulphur consists of calcium sulphate, calcium carbonate, free sulphur, and additional impurities present in the ingredients. As all these materials, in the quantities present, are worthless as spray materials, it is obvious that this sludge has no spray value.

Self-boiled and Dry-mix Sprays.

Owing to the damage frequently experienced by applying summer sprays of lime-sulphur, attempts have been made from time to time to introduce compounds of lime and sulphur less liable to cause injury. Of these the following preparations have come into more or less general use:—

Self-boiled Lime-sulphur.—This was recommended by Scott (1909) in place of lime-sulphur as a spray for the control of brown-rot of peaches. It is prepared by mixing quicklime with sulphur and adding water, advantage being taken of the heat generated by the slaking lime to bring about a certain amount of chemical action between the lime and the sulphur. The resultant spray consists of a mixture of lime and sulphur particles held in a weak solution of lime-sulphur. The fungicidal value of such a spray is dependent upon the weak lime-sulphur formed and the free sulphur in the mixture. A more exact spray could be prepared with less effort by adding colloidal sulphur at the rate of 2 lb. per 100 gallons to a lime-sulphur containing 0·083 per cent. polysulphide.

Dry-mix Sulphur-lime.—This spray was introduced by Farley (1923), and was prepared by mixing 8 lb. of sulphur, 4 lb. of hydrated lime, and 8 oz. of calcium caseinate spreader with 50 gallons of water.

Robinson (1924) suggested that the spray be modified by the use of 2 quarts of skim-milk in place of the calcium caseinate spreader, this alteration producing the spray known as the "Oregon cold-mix sulphur-lime."

Both are but mixtures of lime and sulphur with a spreader, and as neither lime nor spreader is fungicidal to any appreciable extent, it is evident that their value as sprays is governed by the sulphur content and the type of sulphur used. Such being the case, it would be preferable to use a colloidal sulphur at the rate of from 2 lb. to 4 lb. per 100 gallons of water.

Dry Lime-sulphur.

In the United States several manufacturers have placed upon the market a material known as dry lime-sulphur, which is a coarse powder prepared by the dehydration (in the presence of a stabilizer, such as sugar) of commercial concentrated lime-sulphur. The advantages claimed are saving in freight due to the extraction of water, avoidance of losses through leaking containers, and a reduction in the amount of spray injury. The high price of the dried product when considered in relation to the quantity necessary to prepare the diluted solutions, and its uncertain composition, preclude the use of this material in preference to liquid concentrations of local manufacture. Robinson (1924) has shown that there occurs in the dry material partial decomposition of the polysulphides, with a consequent increase in the thiosulphate content.

Effects of Lime-sulphur upon Fungi, Insects, and Plants.

When a diluted solution of lime-sulphur is applied to a tree it undergoes certain chemical changes, with the result that ultimately only calcium carbonate, calcium sulphate, and free sulphur in a finely divided state remain. The polysulphides are converted into free sulphur, the monosulphide to hydrogen sulphide, and the thiosulphate into calcium carbonate and sulphate, and possibly free sulphur.

Action on Fungi.—It is not known whether the polysulphides are directly fungicidal, as has been suggested by Eyre and Salmon (1916), or whether lime-sulphur acts on account of the free sulphur liberated as a result of its decomposition, as has been claimed by Young (1922). It is probable that its fungicidal value over a period is due to this free sulphur, since, shortly after application, this appears to be the only substance present upon the tree in addition to the inert materials mentioned. It does not appear that the hydrogen sulphide produced as a result of the decomposition of the calcium monosulphide has any material effect, since Horton and Salmon (1922) have shown that the monosulphide when tested alone had little fungicidal value.

Action on Insects.—It would appear that the insecticidal action of lime-sulphur is due (Tartar, 1914) to (1) its power of absorbing oxygen (thus asphyxiating insects); (2) its ability to soften wax newly secreted on the margins of scales (thus tending to imprison the young by causing the scale cover to adhere firmly to the tree); and (3) by the free sulphur which is liberated (known to possess a certain insecticidal value).

As an ovicide lime-sulphur appears to be of little value, according to Theobald (1914) and Parker (1923), and this has been confirmed under New Zealand conditions by the Entomologist of this Station, Mr. J. Muggeridge, who found it was not toxic to the eggs of European red-mite when tested as a 1-per-cent. polysulphide solution.

Scott and Siegler (1913) claimed that it acted as a stomach poison against fall web-worm and codlin-moth; but Theobald (1914) found it had too slight an effect in this connection to permit of its replacing the arsenic sprays.

Action on Plants.—Leaf-scorch and fruit-russet have frequently been experienced following summer applications of lime-sulphur in New Zealand, and elsewhere it has been found to cause defoliation and dropping of young fruits. Numerous theories have been expounded to account for this injury, the position being well summarized by Shoemaker (1924), who has grouped them under the following heads: (1) Injury due to the soluble polysulphides; (2) to absorption of lime-sulphur by the chlorophyll; (3) to the effects upon the spray of sunlight, heat, gas, acids, and oxidation; (4) to the minuteness of the sulphur particles deposited as a result of its decomposition. Shoemaker concluded that it was not possible as yet to arrive at any definite conclusion as to whether any one factor was responsible for lime-sulphur injury under all conditions.

It is certain that in New Zealand, at any rate, frequent cases of lime-sulphur injury have resulted in consequence of applications being made at too great a concentration, owing to the practice of determining strengths by the specific gravity of the solution.

Uses of Lime-sulphur.

It has been customary in New Zealand to use this spray as a winter insecticide against scales, woolly-aphis, and red-mite eggs, and as a winter fungicide for both pome and stone-fruit diseases. As a summer spray it has been used as a fungicide against leaf-rust and brown-rot of stone-fruits, black-spot and powdery-mildew of apples, and as an insecticide against red-mite and young scales, and to a less extent against aphis.

Experiments conducted during the past two seasons (previous experiments with summer sprays cannot be considered, since the concentrations at which they were applied are unknown) with sprays diluted in accordance with the polysulphide content have shown that lime-sulphur will combat black-spot and powdery-mildew without appreciable injury to fruit or foliage. It is reasonable to suppose that at these new dilutions it should prove equally effective for control of brown-rot and leaf-rust of stone-fruits, but as yet we have no experimental data in support of this. As a winter fungicide it has proved to be slightly inferior to bordeaux mixture as a foundation spray against black-spot, and decidedly inferior to both bordeaux and burgundy mixtures against leaf-curl of peaches.

Red-mite has been held in check during the summer by applications at ten-day intervals of sprays containing 0·1 per cent. polysulphide. As extension of the interval between each application has given unsatisfactory results, it is evident that it is not a satisfactory spray

for this purpose. As a winter spray it has failed to destroy red-mite eggs; but it has given satisfactory results against San Jose scale, even at dilutions in excess of those now recommended.

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* The services of this officer have been made available for chemical investigations of sprays, by a grant from the Scientific and Industrial Research Department.

PULPY KIDNEY DISEASE OF LAMBS.

NOTES ON INVESTIGATIONAL WORK IN 1931 SEASON.

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NOTES on the 1930 season's work on pulpy kidney disease, published in this *Journal* for May, 1931, recorded that a highly toxic substance was present in the small intestine of affected lambs, and that it was intended to verify this and search for the cause of it during the 1931 season.

The centre from which the pulpy kidney work had been carried out since the commencement of the present investigation in 1926 was Ranfurly, in Central Otago, but the progress of the work was greatly hampered there by the lack of such facilities as electric power and a good water-pressure, and although it was unfortunate to leave such a district, where one knew the affected farms well and the farmers were accustomed to co-operating with us, it was felt that more rapid progress would be made in a centre such as Oamaru, where there were better facilities for detailed work.

Through the courtesy of the Waitaki Farmers' Freezing Co. we were able to fit up a small laboratory at the Pukeuri Meat-works, and to use that as headquarters. It is a pleasure to acknowledge here the kindness and consideration shown by the works manager, Mr. McEwen, and his staff.

The articles on this disease that have appeared each year in the *Journal* have only been summaries of the much more detailed reports that have been submitted to the Department, as it has been considered unnecessary to burden readers with technical matters concerning research as to the actual cause of the disease until some definite pronouncement could be made.

When the second (1928) year's work on the subject had been completed we were of opinion that the cause lay in the production and absorption into the lamb's body of toxins formed in the intestines, and suggested (Departmental report) that an organism such as *Bacillus welchii*, or one of a similar nature, was a very likely culprit. Evidence in support of this view was sought during the following season, but owing to the lack of facilities at Ranfurly referred to above this could only be done by various indirect means, none of which was successful. Plans were made for a more definite search for the presence of toxins in the gut contents during the 1929 season, but owing to the writer's absence from the country they were not carried out till 1930. This time positive evidence of abnormal toxin-production in the small gut was obtained, and, as this was the first real clue to the cause of the disease, full details of the work and results were sent to various research workers in Australia, England, and elsewhere, who were interested in the same problem, in addition to the summary published in the May, 1931, issue of the *Journal*.

A fact that was not mentioned in last year's published report was that the toxin in the affected lamb's intestine was readily destroyed by quite a moderate degree of heating, and that there was strong

presumptive evidence that it was the toxin of some particular micro-organism. In the *Veterinary Journal* of September, 1931, Montergomerie, a veterinary research worker in North Wales, published the results he had obtained along similar lines, which amply confirmed our own.

The 1931 season's work at Oamaru was hindered to a great extent —just as was the previous year's at Ranfurly—by scarcity of affected lambs to work on. It had been an extremely bare, dry winter in North Otago, with the result that the ewes were not in their usual condition at lambing, and shortage of feed after lambing still further reduced the milk-supply. In spite of this, however, it was possible to confirm the presence in the small intestine of a highly potent toxin that was still present when the material was passed through a bacteria-proof filter, and was easily destroyed by heat. Had a plentiful supply of affected lambs been available, it was intended to attempt the identification of the organism that was producing this toxin by finding what sort of antitoxins would or would not neutralize it.

With few exceptions, the germs that produce powerful toxins are of the class known as anaerobes (that is to say, they cannot be cultivated except in an atmosphere from which the oxygen has been removed), and this, together with certain other features of the disease, and the fact referred to above that *Bacillus welchii*, which is an anaerobe, was considered a likely cause on theoretical grounds, all helped to narrow down the search. In 1930 one attempt was made to neutralize the toxin in the gut contents with the antitoxin against the lamb dysentery bacillus, which is closely allied to *B. welchii*, and whose antitoxin will neutralize the toxin produced by that organism as well as its own. No neutralization occurred. This season, again, only a very small amount of this type of work could be done, but lamb dysentery antitoxin was tried once more and failed, and so did an antitoxin prepared against the malignant oedema organism. Although we do not place any reliance on our own results in this connection, in view of the small number of experiments made, it may be said that Montergomerie had similar results, and also tried *Bacillus oedematiens* antitoxin and found it useless.

Concurrently with this work the small-gut contents of the few suitable affected lambs that were available were cultured, and an organism very similar to *B. welchii* was obtained in almost pure culture from them. These cultures were brought back to Wallaceville for further study, and proved exceedingly interesting. They had every appearance of being *B. welchii* cultures, and produced toxins which killed mice in a manner identical with those killed by the lamb gut toxins, but it was found that in spite of appearances the organisms were not strains of *B. welchii*, because *B. welchii* antitoxin would not neutralize their toxins. (Toxin-antitoxin trials are the recognized criteria as to whether similar toxin-producing organisms are identical or not.)

Some antitoxin was then obtained from Bennetts, a veterinary research worker in Western Australia, who had discovered a new organism, also similar to *B. welchii*, as the cause of a sheep disease having many points of similarity to pulpy kidney disease of lambs, although it affects adult sheep generally. He had named his organism

Bacillus ovitoxicus. On testing his antitoxin against the strains obtained from Oamaru lambs it was found to neutralize their toxins very strongly.

When this was discovered it was decided not to publish the results till a series of standardized toxins and antitoxins could be obtained from England, with which to put the Oamaru strains through a very thorough test. This was considered necessary, because if the Oamaru strains were actually the same as *B. ovitoxicus* then lamb dysentery antitoxin should have neutralized their toxins, and in the few trials made (see above) the toxin in the lambs gut had not been so neutralized. Moreover, it was hoped to show by experiments on lambs in the early spring that these strains could actually set up the disease.

This decision was unfortunate as it happens, and has been changed, because a publication lately received from Australia—the *Journal of the Council for Scientific and Industrial Research*, February, 1932—gives a brief account of similar work on pulpy kidney carried out by Oxer, in Tasmania, in which he has isolated organisms similar to ours in New Zealand. He not only considers these identical with Bennetts's *B. ovitoxicus*, but has obtained fair evidence that this is, in fact, the organism which causes the disease.

It must be stressed in conclusion that these findings in no way interfere with the view expressed in previous articles that nutrition has a great predisposing influence. For some years now it has been the writer's view that a form of digestive disturbance occurred which gave some organism the opportunity it would not otherwise have had to grow and produce its toxin in the small intestine, and that the reason why the incidence is highest when the lambs are doing best is that they are getting abundant (perhaps overabundant) milk, and hence are more liable to digestive disturbance than they would be if they had less milk and more exercise.

Digestive disturbances from other causes than a too abundant supply of milk undoubtedly occur among lambs, especially at the age of about three weeks, when they are changing over from suckling only to suckling plus grazing. It is probably these conditions which predispose to the disease, and thus account for the losses that sometimes occur among lambs which are in only moderate condition.

In all probability the beneficial effect of yarding for twenty-four hours every five to seven days is due not only to the temporary starvation incurred, but to the fact that the ewe's milk when she comes out of the yards is reduced in quantity but contains an unusually large amount of fat. The effect of this on the lamb's empty stomach and intestine is probably that of a mild but efficient laxative.

Testing of Rye-grass Seed.—Whenever permanent pastures are being laid down and perennial rye-grass is included in the mixture, the Department of Agriculture recommends that certified perennial should always be used. However, it may not always be possible to secure certified seed, and in such cases farmers are urged to demand from the merchant who is supplying non-certified seed a guarantee that the seed has been tested by the Department's Seed-testing Station with ultra-violet light, and that it has been reported to be a perennial type. Attention to the type of rye-grass sown is of paramount importance in the laying down of permanent pasture.

WEED HOST PLANTS OF CLUB-ROOT IN NEW ZEALAND.

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THE following experiments have been conducted to determine the weeds upon which club-root, *Plasmodiophora brassicae*, may live in New Zealand.

Material for testing was secured by collecting seeds from cruciferous weeds during the summer of 1928–29. The seeds were sown on club-root-infected soil and the seedlings examined microscopically for the presence of the disease. In all, five sowings were made, and while four of these produced a number of infected plants, only two are considered as having afforded ideal conditions for the development of the disease. In the others, damping-off, cold weather, or unsuitable soil permitted of tests that were only partially satisfactory.

In one test, in which club-root developed strongly on most species, the roots of members of those species resisting infection were dipped in a spore suspension and transplanted to boxes wherein the organism had developed freely.* No further species became infected. Those resisting infection under these conditions were American cress (*Barbarea verna*), *B. stricta*, *B. vulgaris*, and twin cress (*Coronopus didyma*). In one sowing on unsuitable soil club-root failed to develop, but the roots of all plants showed small definite isolated swellings 1·5–2·5 mm. high by 6–8 mm. long and up to 3 mm. wide inhabited by a species of eelworm. The plants so attacked were *Barbarea verna*, *B. stricta*, *B. vulgaris*, *Diplotaxis tenuifolia*, *Cardamine heterophylla*, *Erophila vulgaris*, *Lepidium ruderale*, *Sisymbrium officinale*, *Alyssum calycinum*, and *Brassica oleracea*. Though similar lesions occurred on *Lepidium campestre*, *Brassica campestris*, and *Raphanus sativus*, neither eelworms nor other causes were in evidence under the microscope.

In the accompanying table is shown the infections resulting in four tests in which seed was sown on infected ground. In the second test, conducted in a glasshouse, only a few species were sown, all of which are recorded. In the other tests, though most of the species were sown, only those that grew normally are recorded. The table also indicates whether the species mentioned are common to field, garden, or wayside, &c., and reference is also made to papers in which are recorded the results of previous infection tests by other workers.

Of those plants infected, *Erophila vulgaris*, *Cardamine heterophylla*, *Sisymbrium orientale*, and *Diplotaxis tenuifolia* do not appear in the available lists, and are believed to be unrecorded hosts. The susceptibility of *Erophila vulgaris* is of little practical importance in New Zealand, as it grows in the arid area of Central Otago, which is not generally considered subject to club-root. *Cardamine heterophylla*, a native of the bush fringes and clearings, may prove of more importance through perpetuating club-root spores dropped in dung of stock. *Sisymbrium orientale* and *Diplotaxis tenuifolia* are of only limited

* The check of transplanting usually, though not always, appears to increase the susceptibility of plants to club-root.

Club-root Infection Data, &c.

Key to distribution of hosts: F = field weed; W = wayside weed; G = garden weed.

Host Plant.	Natural Distribution of Hosts.	Test 1.		Test 2.		Test 3.		Test 4.		Infection recorded previously by
		Number of Plants.	Number clubbed.	Number of Plants.	Number clubbed.	Number of Plants.	Number clubbed.	Number of Plants.	Number clubbed.	
Barbarea stricta ..	W G	61	..	61	..	31	..	..	..	Cunningham, 7 per cent.
Barbarea verna ..	W G	46	..	116	..	46	..	35	..	..
Barbarea vulgaris ..	W G	12	..	46	..	12	..	..	..	Naoumoff, 1 plant = 6 per cent.; Hammarlund.
Brassica arvensis ..	W F	26	..	..	..	..	..	51	51	Halsted, *B. sinapistrum*.*
Brassica campestris ..	F	30	30	89	63	3	2	68	65	Cunningham, 5·5 p.c.; Naoumoff, 6 per cent.
Brassica oleracea—										
Gisborne	Coast	22	3	109	78	..	..	..	..	..
Waikanae ..	W	..	..	..	..	..	..	25	25	..
Oamaru	Coast	22	..	..	..	..	..	12	12	..
Cardamine heterophylla	Bush	4	2	33	24	..	..	10	10	..
Coronopus didyma ..	G F W	11	..	20	..	8	..	67	..	..
Coronopus procumbens	F W	..	..	..	..	4	..	22	..	..
Capsella bursa-pastoris	F G	..	..	1	1	1	..	7	6	Halsted, Cunningham, 57 per cent.; Naoumoff.
Cherianthus cheri ..	Cultivated	6	..	..	..	3	..	21	18	Halsted.
Diplotaxis muralis ..	G W	48	2	..	..	..	..	1	1	Naoumoff, 10 per cent.
Diplotaxis tenuifolia ..	W	55	9	..	..	..	..	36	36	..
Erophila vulgaris ..	F	..	..	28	1	..	..	51	11	..
Lepidium tenuicaule ..	Coast	50	..	..	..	..	..	6	..	..
Lepidium ruderale ..	F G	91	..	18	12	..	..	8	4	Naoumoff, 90 per cent.
Lepidium campestre ..	F	26	..	16	16	..	..	18	18	Halsted, Cunningham, 39 per cent.
Lepidium virginicum ..	W	30	3	..	..	..	..	..	..	Halsted, Naoumoff, 17 per cent.
Matthiola incana ..	..	..	..	..	..	..	..	56	..	Naoumoff, 0 p.c.; Mueller and Osterwalder, 0 p.c.; Halsted 0 p.c.
Nasturtium officinale	Ditches	..	..	..	..	..	..	2	..	..
Nasturtium palustre ..	River-bed	5	..	..	..	..	..	..	..	Halsted, Naoumoff, 0 p.c.
Raphanus sativus ..	W	11	..	..	..	9	..	19	..	Halsted, Cunningham, 53 per cent.; Naoumoff.
Raphanus sp. ..	W	4	..	..	..	5	..	8	..	..
Lunaria biennis ..	G	46	12	..	..	..	..	18	18	..
Sisymbrium sophia ..	..	4	3	..	..	..	..	18	..	Hammarlund, Naoumoff, 20 per cent.
Sisymbrium orientale	G	27	..	43	4	4	4	..	..	..
Sisymbrium officinale	F W G	22	..	65	39	..	..	59	59	Naoumoff, 100 per cent.; Mueller and Osterwalder, 0 per cent.
Arabis albida ..	Cultivated	..	..	..	..	12	3	29	13	Naoumoff, 0 per cent.

* As Halsted's paper (1897) is not available, references to his list of hosts have been drawn from Naoumoff's paper of 1925.

distribution, the former in gardens in Auckland, the latter about Oamaru, and are hence comparatively unimportant. In addition to these, the crop hosts mentioned in the next sentence have been determined by dipping the roots of seedlings in a suspension of

club-root spores prior to planting in soil free from the disease. By this means swedes, turnips, thousand-headed kale, buda kale, chou moellier, mustard, cabbage, cauliflower, broccoli, and brussels sprouts have been shown to be susceptible to attacks of club-root under New Zealand conditions.

In order to ascertain whether club-root spores collected from weed hosts were capable of infecting field crops, suspensions of spores were made from tumours on *Brassica arvensis*, *B. campestris*, *B. oleracea*, *Diplotaxis tenuifolia*, *Cherianthus cheri*, *Lunaria biennis*, *Lepidium campestre*, *Sisymbrium orientale*, and *Arabis albida*, and distributed over rape plants growing in a glasshouse in boxes of sterilized soil. Club-root infection occurred in every case.

Practical Significance of Weed Hosts.

Club-root spores are frequently disseminated on so-called virgin land (unstumped pasture and standing bush) by feeding out infected crops or by the infected dung of stock. Under favourable conditions weed hosts would perpetuate the organism on this type of ground, and this may offer an explanation of the apparently inexplicable infections that occur when such areas are eventually cleared and sown to swedes.

Mr. R. B. Tennent, Fields Superintendent, Dunedin, and Mr. Faithful, Instructor in Agriculture, Gore, have forwarded club-rooted specimens of shepherd's purse collected from swede crops. Infected plants of shepherd's purse have been found by the writer in an oat crop, and infected wild turnip in grass pasture. Thus the presence of susceptible weeds on infected soil will reduce the effectiveness of crop rotations on club-root control. Fortunately, susceptible weeds are not usually sufficiently numerous to maintain the heavy infection of an area, and during the course of a rotation a large number of spores will become "starved out." Where weeds are present it is probable that a few spores will be perpetuated, and that these will cause a small amount of infection on a subsequent cruciferous crop. Such infections frequently pass unnoticed, but the spores become so multiplied that a following susceptible crop is seriously attacked.

Obviously the eradication of weed hosts from pasture and oat crops is impracticable, and the presence of such weeds on a farm where club-root commonly occurs clearly indicates the impracticability of club-root eradication by "spelling" or crop rotations. Thus, where spores of the disease have survived the period of the rotation, the ability to grow a series of cruciferous crops is limited unless precautions, such as liming and the use of disease-resistant strains of seed, are taken to prevent the development of the disease.

The writer's thanks are due to the late Mr. H. Carse, of Auckland, and Mr. R. M. Laing, of Christchurch, who assisted in the collection of weed seeds, and especially to Dr. H. H. Allan, for identifying the plants from which seed was obtained and checking botanical names.

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ABNORMAL CHEESE FLAVOURS DUE TO WEEDS IN PASTURE.

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SOUND clean cheese flavour is the most important feature of a good Cheddar cheese. It is not definitely known what factors and substances in cheese give rise to desirable flavour; but it is generally recognized that unclean flavours develop when the flavour of the original milk is in any way affected. Bacterial action is the most common source of abnormal flavours. Frequently, however, there can be detected in freshly-drawn milk, feed flavours which persist after cooling, aeration, and pasteurization.

These flavours are similar to the smell of the causal foods. Dairy cattle foods in New Zealand which are known to affect the flavour of milk include (1) cruciferous crops, such as turnips, swedes, cabbages, rape, and chou moellier; (2) leguminous crops in the green state, such as lucerne, Lotus major, Lotus angustissimus, and possibly white clover while in flower; (3) green forage crops such as maize, millet, and oats and tares. Certain weeds in pastures impart a distinct flavour to milk, notably pennyroyal (*Mentha pulegium*), twin-cress, known locally as land-cress (*Coronopus didimus*), watercress species (*Nasturtium* sp.), and buttercups (*Ranunculus* sp.).

Food flavours are generally more pronounced in cream than in milk because they are absorbed by the butterfat; and they can be readily detected in butter at any time after manufacture. "Scorched" taints in butter due to this cause are often wrongly attributed to high pasteurization temperatures. They are more difficult, however, to detect in cheese after it has started to develop its flavour. They may be observed in curd and in cheese for the first fourteen days after manufacture; soon afterwards, their characteristic odours and tastes are changed by cheese flavour.

In the course of experiments at the Dairy Research Institute, unique opportunities occurred for tracing the influence on the flavour of mature cheese of abnormal flavours in milk caused by twin-cress and pennyroyal.

Twin-cress Flavour.

This was observed at the customary grading of experimental cheeses when fourteen days old, on eight days, at intervals in September and October, 1930. Of a total number of thirty-seven cheeses, made from four small vats of milk per day, thirty-one showed distinct evidence of cress flavour. Grazing records showed that the College herd from which the milk was drawn grazed two particular fields in either the day or the night time previous to the days on which were made the cheeses affected with the flavour.

Examination of the herbage in these fields revealed the presence of twin-cress to a limited extent in areas where the pasture sole had been slightly opened by occasional soaking with surface water. The fields in question were in first-year pasture, having been seeded to permanent pasture in the previous March, and were grazed in accordance with the accepted practice of rotational grazing, which accounts for the flavour occurring at intervals in the two months. At this time there was much luscious growth. Although the dairy herd continued to graze these fields at intervals throughout the season, no cress flavour was detected in the cheese later in the season.

The flavour was observed in the milk when the latter was delivered to the factory, on six of the eight days on which the cheese flavour was affected. It persisted after the milk had been pasteurized in a flash regenerative pasteurizer at 150° F. in accordance with standard New Zealand practice. It was noticeable in the curd during manufacture. When the cheeses were examined at fourteen days old certain of them carrying slightly high acidity exhibited the flavour to a greater degree than did those of normal acid. The abnormal flavour showed up equally distinctly in cheese from milk of high fat content as in cheese from milk of low fat content.

All of the cheeses were exported to England and were individually graded at the Wellington grading-stores when from three to four weeks old. By this time the flavour had altered to a peculiar pungent type not distinctly indicative of its source to a grader with no previous knowledge of the history of the cheese ; and, again, the full acid cheese had the more distinct and objectionable flavour. The cheeses were later examined in England, first on arrival, when three to four months old, and again two months later. The judges were given no particulars of the manufacture of the cheeses or of their previous examinations. At the first examination they described the flavours of all as " unclean," two as " bitter," four as having a " scorched " flavour, and one " herby." At the second examination a number were described as " dirty," three as " bitter," five as " scorched," and two as " metallic."

The bitter and metallic flavours are more attributable to excess acid than to the products of the original cress flavour ; but it is noteworthy that the original flavour had altered beyond easy recognition. The reference to " burnt " and " scorched " were reflections of the previous pungent and biting flavours altered by those derived from the normal ripening process. These were not attributable to pasteurization of the milk, which was carried out at a low temperature to avoid " cooked " flavours. In any case, a scorched milk flavour changes to bitterness as cheese matures.

Pennyroyal Flavour.

This was detected in each of nine cheeses made on behalf of the Institute, from two vats, in February, 1931, at a factory in the vicinity of Palmerston North. The milk used was drawn from several farms and was pasteurized at a temperature of 150° F. by an ordinary regenerative flash pasteurizer. These cheeses formed part of a series concerned with factors influencing the rate of ripening. One lot of nine was made from milk to which more rennet had been added than had been added to the other; and since the nine individual cheeses were examined after storage periods of from nine weeks to twenty-four weeks there was an opportunity of studying the influence of ripening on the original pennyroyal flavour. When graded at fourteen days, those cheeses made from milk treated with 5 oz. of rennet per 1,000 lb. showed a more distinct flavour than did those from milk to which 3 oz. of rennet per 1,000 lb. of milk were added. As the cheeses matured the distinct pennyroyal flavour gradually changed to an objectionable pungent aroma and biting taste, again due to the influence of normal flavours produced in cheese ripening.

The country from which the milk used in the manufacture of these cheeses was drawn is low-lying silt, and subject to flooding from time to time, with the result that conditions are ideal for the growth of pennyroyal, and, being relatively late in flowering, any plants in the pasture would at the time of the experiment be in flower.

Methods of dealing with Milk affected by Food Taints.

There is no known method of removing twin-cress and pennyroyal flavours from milk. Careful cooling and aeration of the milk in a clean atmosphere will help to reduce it slightly. Pasteurization of milk is also of slight benefit; but none of these methods is really effective in removing the taint. It is not practicable to remove odours from milk for cheese-making by treatment in an ordinary cream deodorizer because of changes in the constitution of the milk which make it unfit for cheese-making. The rejection of tainted milk is the only effective method of avoiding the trouble: the milk of one supplier may quite well affect the whole output of one vat of nine cheeses, and, indeed, may affect the whole factory supply coming in contact with equipment over which tainted milk has passed. Dairy factory control, therefore, depends upon the careful inspection of milk at the receiving stage before mixing it with the general milk supply. Absolute control, however, lies with the supplier, whose duty it is to keep his pasture free from these weeds.

Description of the Plants and Methods for their Control.

Twin-cress (also known as wart-cress or land-cress) is an annual found throughout New Zealand. It has slightly hairy, trailing stems which spread over the ground and may grow up to 18 in. in length. The leaves are finely divided or "cut"; the flowers are very small, inconspicuous, and may be green or white. When crushed between the fingers the plant has a strong smell.

The most characteristic feature of the plant is the fruit or pod. The pod consists of two kidney-shaped halves, joined together and supported on a slender stalk; and each half contains a seed. There may be as many as forty of these pods on one branch, and scores of branches per plant. Twin-cress flowers over a long period, and is constantly producing

seeds which drop off as they ripen. The equal division of the fruit into two halves has led to the adoption of the name twin-cress.

Twin-cress is more frequent in waste places or on bare ground than it is on permanent pasture. It is commonly found around the cow-shed, in cattle-races, around gateways and similar places pugged by stock. If by reason of faulty seed, cultivation, or management the pasture is weak, and there is a lack of vigorous competition, twin-cress

FIG. 1. TWIN-CRESS (NATURAL SIZE).

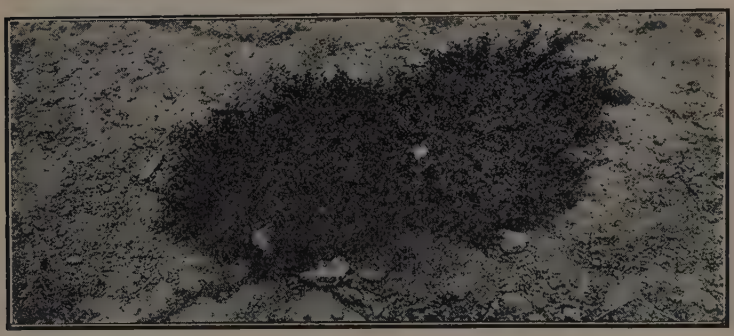

FIG. 2. SHOWING SPREADING HABIT OF GROWTH OF TWIN-CRESS.
Photos by J. S. Yeates.

may become a weed in pastures. In a vigorous-growing close pasture it should not feature. It is more common in young pastures than in old ones. It should be avoided in young pastures by using clean seed, and by careful cultivation. If a field is affected it may be controlled by allowing the pasture to become somewhat rank, thereby smothering the weed, or, if circumstances permit, by hoeing it out. The weed should be cleared from any waste places to which milking cows have access.

Pennyroyal is a perennial plant with a creeping root and trailing habit. The stems are much branched and square, and up to 12 in. long. The leaves are spear-head shaped and entire—that is, not "cut" as in the cress. The flowers are lilac-blue and crowded into close circular bunches at intervals along the stem. The whole plant, in common with the other members of the mint family, has a very strong odour due to the presence of aromatic oils.

Pennyroyal is found in waste places and pastures on moist land in both Islands, but is very prevalent in the northern part of the North Island, where it constitutes a menace to the dairy-farmer. It is classed on many farms as following blackberry, Californian thistle, and ragwort in importance as a weed.

When pennyroyal is prevalent over a large area it may be advisable to drain and lime the land. If the land can be ploughed, quick-growing smothering crops should be grown for one or two years prior to sowing down to grass again. Non-ploughable land should be top-dressed with

FIG. 3. PENNYROYAL (TWICE NATURAL SIZE).

lime or slag, and the field closed to stock from early spring to the end of December. The rank growth will smother out much of the weed-growth. This method is not advised except under extreme conditions of weediness. Smaller areas can be sprayed with 1–80 arsenic pentoxide solution (=1¼ lb. of the arsenic to 10 gallons of water), applied as a very fine spray at the rate of 240 gallons per acre, or with 1–40 sodium chlorate solution (=2½ lb. of the chlorate to 10 gallons of water) at the same rate of application.

Care must be taken in applying these sprays; the former is poisonous, and the latter when dry is very combustible. Precautions given by J. W. Deem, in this *Journal*, Vol. 40, page 292, and Vol. 41, page 3, should be carefully observed when using sodium chlorate.

We wish to express our thanks to Mr. W. Jacques, of the Massey Agricultural College staff, for supplying the botanical description of the plants and suggestions for methods by which to eradicate them.

TURNIP-MANURING EXPERIMENTS IN THE SOUTH ISLAND.

SUMMARY OF RESULTS FOR SEVEN SEASONS, 1924–25 TO 1930–31.

(Concluded.)

Fields Division, Department of Agriculture.

3. Comparison of Super plus Carbonate of Lime with Basic Super.

Commercial basic supers are prepared in different ways by different firms. Originally basic super was prepared by mixing 85 parts of superphosphate with 15 parts of slaked lime. Made from superphosphate containing 44 per cent. of tricalcic phosphate such a basic super would contain about 37·5 per cent. of tricalcic phosphate (equal to 17 per cent. phosphoric anhydride approximately). Such a basic super was prepared for the trials, the mixing being done at least a week, and in some cases several weeks, before sowing. It will be referred to here as "special" basic super.*

A commercial line of basic super containing 41·5 per cent. of tricalcic phosphate (= 19 per cent. of phosphoric anhydride) was obtained. The method of preparation of this material was a "trade secret." If it was a mixture of super and lime the amount of lime introduced must have been small. The phosphate content coincides very closely with what would be obtained by mixing 60 parts of super, 20 parts of Nauru phosphate, and 20 parts of lime.

Five experiments were carried out in 1929–30, comparing the following per acre treatments: (1) Super 1 cwt. plus carbonate of lime 1 cwt., (2) special basic super, 132 lb., (3) commercial basic super, 1 cwt. The super and lime, and special basic super, supplied the same amounts of phosphate per acre, but the commercial basic super supplied a little less: 119 lb. would be required to equal 1 cwt. of super in amount of phosphate. Four of the experiments were sown in 14 in. rows, the other being in 7 in. rows. The average results of these five experiments are as follow:—

	Average Field Germination: Plants per Area 10 ft. by 14 in.	Average Yield in Tons per Acre.
Super 1 cwt. plus carbonate of lime 1 cwt. ..	20·3	18·1
Special basic super 132 lb.	20·1	17·6
Commercial basic super 1 cwt.	20·7	16·2

The germinations did not differ significantly from one another in any of the five experiments. The yield from super plus lime was significantly better than that from special basic super in one of the five experiments only by 1·6 tons per acre. In the remainder the differences were small and not significant.

Super plus lime was significantly better than commercial basic super in four of the five experiments, the average superiority for all trials

* The method of preparing the "special" basic super was supplied by Mr. R. McGillivray, Fields Superintendent, Christchurch.

being 1·9 tons per acre. Special basic super was significantly better than commercial basic super in three of the five experiments.

The superiority of super plus lime and special basic super over the commercial basic super would seem to be greater than can be accounted for by the slight differences in amount of phosphate supplied.

NOTE.—A sample of the same line of commercial basic super, used in the 1931–32 season, was analysed and found to contain 20·4 per cent. of phosphoric acid (P_2O_5). This is about equivalent to the amount contained in super.

4. Sowing in 14 in. Rows compared with sowing in 7 in. Rows.

Where sowing on the flat is practised the most common method adopted is that of sowing through every second coulter of the drill. Sowing in 7 in. rows is, however, quite commonly practised in certain districts, especially in South Canterbury. It seemed reasonable to suppose that sowing the same amount of seed per acre through every coulter would give a more even distribution of plants over the ground; and it has been shown that halving the quantity of super per row, when straight super is used, reduces germination injury considerably. (See Section 1 (2 *a* and *b*) and (3 *a* and *b*) above.) The two methods were compared directly in six experiments. Super alone was used on only one of these and super plus carbonate of lime in five. The same amount of seed *per acre* was used as near as possible. Generally, however, it was difficult with the drills used to get exactly the same amount of seed per acre in both cases. Seeding through every coulter (7 in.) meant that the rate of sowing *per row* had to be half of that of the 14 in. rows. As a rule the seeding per acre was a little greater when sowing was done through every coulter (7 in.) than when every second coulter (14 in.) was used. The results obtained were as follows :—

(1) Using super 1 cwt. per acre in *one* experiment—8·6 oz. of seed per acre was used in sowing the 14 in. rows and 10·1 oz. in sowing the 7 in. rows, with the following results :—

	Field Germination: Plants per Area 10 ft. by 14 in.	Yield in Tons per Acre.
14 in. rows	9·0	15·3
7 in. rows	16·6	16·8
Difference	46 per cent.	1·5

The difference in rate of seeding was about 15 per cent., but the difference in germination was 46 per cent. So far as this experiment is a guide, it is better to use 7-in.-rows sowing when straight super is used. (See also Section 1 (1 *a* and *b*) and (2 *a* and *b*).)

(2) Using super 1 cwt. plus carbonate of lime 1 cwt. in five experiments, the results were :—

	Average Field Germination: Plants per Area 10 ft. by 14 in.	Average Yield in Tons per Acre.
14 in. rows	14·9	16·5
7 in. rows	19·7	17·3
Difference	24 per cent.	0·8

The difference in germination is probably due in most part to a heavier per-acre seeding in the 7 in. rows. The advantage in yield

is not very considerable and may be due in part to heavier seeding, although consideration of the effect of rate of seeding below does not lend weight to this idea. The simple expedient of sowing through every coulter rather than through every second coulter would appear justifiable, however, on those drills adapted to sowing turnips through every coulter, or where seed is mixed with the manure for sowing.

EFFECT OF INCREASING THE RATE OF SEEDING WHEN SOWING IN 7 IN. ROWS.

In the above experiments the effect of increasing the rate of seeding by 3 oz. or 4 oz. per acre when sowing in 7 in. rows was also tried, with the following results :—

(1) Using Super 1 cwt. per Acre in One Experiment.	Field Germination : Plants per Area 10 ft. by 14 in.	Yield in Tons per Acre.
10·1 oz. seed in 7 in. rows ..	.. 16·6	16·8
13·5 oz. seed in 7 in. rows ..	.. 22·6	17·6
Difference	.. 27 per cent.	0·8

Increasing the number of plants has caused a small (0·8 tons) but significant increase in yield.

(2) Using Super 1 cwt. plus Carbonate of Lime 1 cwt. per Acre in Five Experiments.	Average Field Germination : Plants per Area 10 ft. by 14 in.	Average Yield in Tons per Acre.
8·9 oz. seed in 7 in. rows ..	.. 19·7	17·3
12–13 oz. seed in 7 in. rows ..	.. 28·1	17·3
Difference	.. 30 per cent.	0·0

A 30 per cent. increase in the number of plants has not had any effect on yield. The number of plants resulting from 8 oz. to 9 oz. seeding is fairly high, representing nearly two plants per square foot.

5. Methods of applying Superphosphate to reduce Germination Injury.

On land capable of responding to heavier dressings than 1 cwt. of super, methods of sowing other than those usually adopted to lessen or eliminate germination injury appeared worthy of investigation. Experiments were carried out in each of the seasons 1927–28 and 1928–29 with the object of determining the relative merits of the following : (1) Applying extra super between the rows when 14-in.-row sowing is adopted ; (2) applying extra super as a predrilling (immediately before sowing seed) ; (3) applying extra super as a post-drilling (when plants 2 in. to 4 in. high) ; (4) in the case of sowing in ridges, where part of the manure is drilled below the seed and part with the seed, experiments were carried out at the Gore Experimental Area to determine the effect of varying the proportions of the super sown below and with the seed.

(1) INTER-ROW SOWING OF SUPER.

This method, whereby the manure is sown through every coulter of the drill and the seed is sown through every second coulter, ensures that only half the manure sown is in contact with the seed. Three experiments (two at Methven and one in South Canterbury)

were designed to give information on this point, the average germination and yield being shown in the following table :—

Table 2.

Treatment. (All Seed sown in 14 in. Rows.)	Average Field Germination : Plants per Area 10 ft. by 14 in.	Average Yield in Tons per Acre.
No manure	16·2	8·8
Super ½ cwt. in 14 in. rows	14·9	15·1
Super 1 cwt. in 7 in. rows	13·7	18·1
Super 1 cwt. in 14 in. rows	12·0	17·6
Super 2 cwt. in 7 in. rows	11·6	20·8
Super 2 cwt. in 14 in. rows	8·8	17·0

Comments on Table 2 : The injury to germination is more or less proportionate to the amount of super sown with the seed. The yields from the manures sown wholly in the seed rows increase up to 1 cwt. per acre, but 2 cwt. per acre shows a tendency to fall off in yield. The manure sown between the rows has proved decidedly beneficial on yield. Super at 1 cwt. per acre in 7 in. rows is slightly superior to 1 cwt. in 14 in. rows ; 2 cwt. of super in 7 in. rows is decidedly superior to 2 cwt. in 14 in. rows. It must be remembered that the seed was in 14 in. rows throughout.

(2) PREDRILLING SUPER.

In the three experiments mentioned above strips of super at 1 cwt. and 2 cwt. per acre respectively were drilled at right angles to the direction of the turnip rows just before sowing of the seed. Unmanured strips were left so that the effect of the predrilled manures could be compared with those sown with the seed only. The quantities of super set out in Table 2 were sown with and between the seed rows. The main features of the results were as follows :—

Predrilling 1 cwt. of super was practically as effective as applying it with the seed or part with the seed and part between the rows.

Predrilling 2 cwt. of super was practically as effective as applying 2 cwt. part with the seed and part between the rows, and distinctly better in all trials than applying the whole of 2 cwt. per acre in the seed rows.

Predrilling 1 cwt. of super caused increases over the super treatments shown in Table 2 ranging from about 2 tons to 6 tons per acre. The biggest increase occurred over the plots receiving only ½ cwt. with the seed, and the least over the plots receiving 2 cwt., in 7 in. rows. This seems a logical result, as the former gave the lowest yield when used alone and the latter gave the highest.

Predrilling 2 cwt. of super caused increases over the super treatments shown in Table 2 of 1 ton to 3 tons greater than those resulting from the predrilling of super 1 cwt. Again the increases were roughly inversely proportional to the effect of the manure drilled in at seeding. The results indicate that if a crop of turnips has been sown with manure and a bad strike results, necessitating resowing, it should not be necessary to use more than, say, ½ cwt. to 1 cwt. per acre of manure at resowing, providing of course that 1 cwt. or 2 cwt. was sown in the first instance. Further, if it is desired to use a comparatively large quantity of super with the crop, it is better to predrill or postdrill (see later) some of the super, using only ½ cwt. to 1 cwt. per acre with

the seed. In view of the benefits of using a super plus lime mixture, however, the risk to germination attending the use of straight super applied with the seed is not justified.

(3) POSTDRILLING OF SUPER.

One experiment has been conducted in the Methven district in which additional quantities of 1 cwt. and 2 cwt. of super were drilled in across the turnip rows when the plants were from 2 in. to 4 in. high. Super 1 cwt. and super 1 cwt. plus lime 1 cwt. were drilled with the seed. The yields from these two treatments applied with the seed did not differ from one another in this experiment, so need not be discussed here.

The postdrilling of 1 cwt. of super caused the yield to be increased from about 18 tons to 24 tons per acre, an increase of 6 tons per acre. The postdrilling of 2 cwt. of super resulted in a further increase over that from the 1 cwt. postdrilled of about 2½ tons per acre. It is problematical whether supplying extra super in this way is better than drilling the whole of it mixed with carbonate of lime at seeding. On land capable of responding to heavy dressing of phosphate it is certainly one way of getting good results, and the cultivation provided by the passage of the drill coulters through the ground is probably highly beneficial.

(4) VARYING THE PROPORTION OF SUPER SOWN BELOW THE SEED AND WITH THE SEED IN "RIDGE" SOWING: RESULTS AT GORE EXPERIMENTAL AREA.

The Southland practice of sowing with ridging-machines which sow in rows about 26 in. apart and have two manure-boxes and two sets of coulters, one of which deposits the manure below the seed and the other with the seed, presents a problem different from that of sowing on the flat with ordinary drills. In order to get information on methods of using manures in ridged crops experiments have been in progress at Gore Experimental Area for three seasons. Some of these results were published in this *Journal* for January, 1930([4]), and November, 1931([9]). The general findings of these experiments are as follows:—

(*a*) Even under the moist conditions at Gore, super sown in contact with turnip or swede seed injures germination.

(*b*) The injury which has occurred has not been reflected in appreciably reduced yields, except in the 1930–31 season. It is customary to sow a fairly heavy quantity of seed when ridging and to thin the plants to a uniform spacing later. Even with reduced germination the number of plants present allows for a good distribution of these even after thinning. No doubt this factor has lessened the loss in yield such as usually accompanies reduced germination when sowing on the flat is practised. However, as stated, in the 1930-31 season a reduction in yield accompanied a reduction in germination. Using 1½ cwt. of super with the seed and 1½ cwt. below the seed—a total of 3 cwt. per acre—caused germination to be reduced to less than half of that resulting where super plus lime was used. The yields were reduced by about 6 tons in a turnip and a swede crop respectively. 1 cwt. of super with the seed and 2 cwt. below the seed caused almost as bad results. Placing all the super—3 cwt. per acre—below the seed gave almost the same results as those from a mixture of super 3 cwt. plus lime 3 cwt., half of which was applied below and half with the seed. It is obvious from this that even under climatic conditions such as

those experienced in Southland the too free use of super alone in contact with the seed is, under some conditions, likely to be accompanied by undesirable results.

(*c*) At Gore, phosphates such as Ephos, Seychelles, basic slag, or a mixture of these with super, appear to give practically as good results as super. (See this *Journal* for July, 1927([5]), August, 1928([6]), and January, 1930([4]).)

(*d*) The use of potash with turnips and swedes has not given outstanding results except in one or two cases. In 1928-29 an increase of about 6 tons of swedes per acre resulted from the use of 1 cwt. of 30 per cent. potash salts. In the same season a similar experiment on turnips showed no results from potash. (*Journal*, January, 1930([4]).) The effect of potash on germination should be noted in the following Section 6 of this report.

(*e*) The use of manures in relation to club-root of turnips, swedes, and other cruciferous crops in districts where this disease is prevalent is of importance. The claims of basic slag, or a mixture of equal parts of super and freshly slaked lime, in conjunction with liming of the ground must be seriously considered. In this connection readers are referred to an article, "Control of Club-root," by J. G. Gibbs, in the *Journal* for January, 1932.

6. Effect of Nitrogenous and Potassic Fertilizers.

(1) EFFECT ON GERMINATION.

Comparatively little has been done in regard to the trial in this series of experiments of nitrogenous and potassic fertilizers. As a preliminary to the anticipated trial of these fertilizers simple trials were carried out in 1929-30 and 1930-31 to determine their effect on germination of rape and turnips, when used at 1 cwt. per acre in conjunction with super and super plus lime, in 14-in. rows on the flat. The effect of sulphate of ammonia was reported on in the *Journal* for February, 1931([7]), when it was shown that the injury to germination was such as to entirely condemn the practice of sowing as much as 1 cwt. per acre with the seed. Thirty per cent. potash salts at 1 cwt. per acre had a similar effect in three trials conducted in 1930-31, only a few scattered plants surviving. Obviously smaller quantities would have a lesser effect, but it is not likely that such small quantities as would have to be used to eliminate serious injury to germination would be very effective on yield. Where potassic and soluble nitrogenous fertilizers are worth using it is obvious that they must be used in such a way as not to come in direct contact with the seed. In the case of sowing on the flat this entails predrilling, postdrilling, or broadcasting. In the case of ridging, the potassic or nitrogenous fertilizers could be sown below the seed, or broadcast before or after sowing of the crop. Representatives of potash interests recommend its application some weeks prior to the sowing of a crop.

(2) EFFECT ON YIELDS.

(*a*) *Potash.*—Potash has not been tried extensively on the turnip crop in experiments during recent years, but a number of experiments have been conducted at the Gore Experimental Area. The only outstanding results are the ones mentioned above in Section 5, subsection 4, and an experiment in which potash was used on chou moellier[8].

(*b*) *Nitrogenous Manures.* Nitrogen in the form of dried blood at 1 cwt. per acre was used in addition to super at 1 cwt. in Canterbury,

in 1924–25 and 1925–26[8]. In 1924–25 it had no effect on yield, but in 1925–26 super plus dried blood registered an increase of 3⅓ tons over super alone. At Gore in 1928–29[4] 1 cwt. of dried blood increased the yield of turnips by 2 tons per acre, but had no effect on the swede crop. In 1929–31 sulphate of ammonia was used at Gore with no result on yield. In the same year sulphate of ammonia was used as a top-dressing in two trials in South Otago, 1 cwt. being applied at seeding, 1 cwt. after thinning, and 1 cwt. at seeding, plus a further 1 cwt. after thinning. The increases, although not statistically significant except in one case, resulted as follows: 1 cwt. at seeding, 1 and 4 tons approximately in the respective trials; 1 cwt. after thinning, 1 and 3 tons respectively; 1 cwt. at seeding plus 1 cwt. at thinning, approximately 5 tons increase in each case.

(3) PREDRILLING AND POSTDRILLING OF SULPHATE OF AMMONIA.

Two experiments were conducted in Canterbury to determine the effect of sulphate of ammonia at 1 cwt. per acre when drilled before seeding and after the crop was 2 in. to 4 in. high. In one of these trials there was no appreciable effect. In the other the results were as follows:—

Table 3.

Manure with Seed.	No Sulphate of Ammonia.	Sulphate of Ammonia 1 cwt. predrilled.	Sulphate of Ammonia 1 cwt. postdrilled.
	Tons per Acre.	Tons per Acre.	Tons per Acre.
Super 1 cwt. plus carbonate of lime 1 cwt. ..	13·6	16·7	17·8
Super 2 cwt. plus carbonate of lime 2 cwt. ..	14·8	19·1	20·3

The increases resulting from the use of sulphate of ammonia were statistically significant, but there was no significance attached to the difference between the sulphate of ammonia predrilled and postdrilled. The indications from this trial, however, are that postdrilling is the more effective. The predrilling of sulphate of ammonia had little or no effect on germination of the crop.

ACKNOWLEDGMENTS.

The Department extends its thanks to those farmers who co-operated in these experiments. The field work in connection with the trials was carried out under the direction of Mr. R. McGillivray, Fields Superintendent, Christchurch, by Messrs. A. Y. Montgomery, W. C. Stafford, and G. G. Calder (Christchurch), E. M. Bates, (Ashburton), R. A. Calder and K. M. Montgomery (Timaru); and under the direction of Mr. R. B. Tennent, Fields Superintendent, Dunedin, by Messrs. T. Sellwood (Oamaru), A. A. Hume (Dunedin), and J. Sleeman (Experimental Area, Gore).

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—A. W. Hudson, Crop Experimentalist.
—J. W. Woodcock, Assistant Crop Experimentalist.

AN EFFECTIVE LICK-BOX FOR STOCK.

THE lick-box for sheep or cattle illustrated in the accompanying photo was developed by Mr. H. M. Besley, of Te Popo, Stratford, from a design originally used by Mr. T. Alexander, of Maxwell. It is simply and solidly constructed, practically non-capsizable, and proof against all normal weather. Nearly one hundred of these boxes have been constructed and are in use in the Te Popo district.

The base consists of two 3 ft. 4 in. by 3 in. heart rimu runners, to which are wired four 6 in. 4 in. by 3 in. heart totara blocks to prevent rotting and give easier access. The remaining timber is clean o.b. 1 in. rimu nailed together, galvanized iron nails being used wherever the lick material will come in contact. All timber is tarred to increase durability.

The measurements of the boards, so as to fit exactly, are as follows: Floor—2 ft. 5 in. by 1 ft., nailed across the centre of the runners; on this board the nail heads at each end are protected by a 3 in. by 1 in. cleat to prevent rusting and give extra strength. Sides—each, one 9 in. board, cut on a 1 ft. bevel at the upper end and an 11 in. bevel at the lower, the longest side measuring 2 ft. 3½ in. Front—a 6 in. board, bevelled to fit on the lower edge, and strengthened in the middle by a 6 in. board dividing the box. Back—two boards, one (the lower) 1 ft., and the other 9 in., each 2 ft. 7 in. long. Top—one board 2 ft. 7 in. by 1 ft.

The top, back, and part of sides are covered externally with a 3 ft. square of 24-gauge plain galvanized iron, nailed round the edges with 1 in. galvanized clouts.

The lick used by Mr. Besley for his stock is an iodized salt, bonemeal, and iron oxide mixture, with the addition of a little molasses, and is readily consumed by both sheep and cattle. In his lick trials he has kept in touch with Mr. W. M. Webster, Veterinarian, New Plymouth, and Mr. B. C. Aston, Chief Chemist, Department of Agriculture.

SEASONAL NOTES.

THE FARM.

Pre-winter Top-dressing.

In normal years one of the weakest features of our grass-farming is the inadequate feeding of stock during winter and early spring. The current year is abnormal on account of the unusually low reserves of feed for the critical winter and spring period. Hence no means of increasing the available feed for the next few months should be overlooked.

In last month's notes it was indicated that it is exceptional if grassland does not respond profitably to phosphates, and that a farmer should make sure that his pastures belong to the exceptional non-responsive class before deciding to carry on without the assistance obtainable from appropriate top-dressing. On that very large area of land which responds profitably to phosphatic top-dressing, phosphates applied in late April or May are known to assist usefully in many districts in the provision of feed for the difficult July to September period. Hence the many farmers who have not already completed an adequate programme should endeavour to their utmost to carry out further top-dressing at the earliest opportunity, so as to obtain the advantage of whatever extra feed develops before the advent of the cold period of little or no growth. Last month the type of top-dressing that is advisable was discussed in some detail in these notes, to which reference may be made.

In recommending pre-winter top-dressing it has not been overlooked that some farmers for financial reasons may prefer spring top-dressing. Those who are forced to adopt spring top-dressing may be assured that it will be effective, but it is not likely to be as effective financially as the pre-winter top-dressing. This arises from the fundamental weakness in grass-land—as a source of stock-feed it is characterized by alternate periods of oversupply and undersupply. Spring top-dressing tends to intensify this weakness, whereas pre-winter top-dressing minimizes it by giving a more even amount of feed directly available from pastures from month to month throughout the year.

As part of an extended programme, the object of which is continually increased production over a number of years, some farmers in this difficult year have more stock than at any time previously, and, as is customary in such seasons, it is impossible to dispose advantageously of what, in the circumstances, are surplus stock. As little but disappointment may be expected from increased stocking unless the larger number of stock is treated at least as well as the previous smaller number, some of our more ambitious energetic farmers are, because of the abnormal season, in a more difficult position than those who have not been planning to increase their production. Especially should those farmers who are wintering more stock than previously give thought to the assistance available from pre-winter top-dressing.

An occasional additional reason for pre-winter top-dressing lies in the fact that the application of fertilizer to broken or rolling country tends to become more difficult and costly after winter rains have made the ground soft and slippery.

Harrowing of Pastures.

The dry autumn which has been experienced in many districts has delayed progress in the grass-harrowing that is widely advisable. The farmer who omits to do such harrowing before the winter is practically sure to be

faced with the task of dealing with uneven pastures in the spring, due to patches of rank growth in the vicinity of the areas which were occupied by droppings undisturbed for any considerable time. The effective grazing of such uneven pastures is seldom accomplished unless stock are punished in forcing them to graze the rank unattractive patches.

Treatment of Young Pastures.

Particular care should be taken at this season in the handling of recently established pastures. The young plants should neither be allowed to become long nor subjected to continuous close grazing. Undergrazing is probably the more serious fault in the management of young permanent pastures, and this is certainly so if Italian rye-grass has been included in the seed mixture. Undergrazing of young pastures tends to shading, with consequent weakening and possibly destruction of certain more slowly developing valuable species. On the other hand, persistent close grazing of young pastures checks the development of the extensive root-systems which beget vigorous pastures. Young pastures are usually most effectively grazed by a relatively large number of stock for a short time only; this avoids selective hard grazing of the more attractive species which is apt to occur under light stocking. Well-controlled grazing leads to a stooling out of young plants in contrast with the drawn habit that follows undergrazing.

Liming.

When liming has been decided upon, as a rule it may be carried out suitably in April or May. If separate dressings of lime and an artificial fertilizer are to be applied to a field within a short interval it is considered preferable to distribute the lime before the fertilizer, as there is then some opportunity for the lime to become incorporated with the soil, and thereby to be able to obviate some undesirable chemical changes that may occur when fertilizer is applied in the absence of lime. If desired, superphosphate and ground limestone (carbonate) may be mixed and applied as one dressing, but superphosphate and burnt lime should not be mixed unless it is known that the mixture will be applied immediately.

With relative rapidity lime makes its way down in the soil, and tends to be washed away and lost. Hence, ordinarily, the working of lime into the soil is not only unnecessary but also disadvantageous in that it hastens the loss.

For grassland, provided transport costs are not a consideration, it is practically immaterial whether ground limestone or burnt lime is employed if these two forms of lime are on an equal cost basis, it being taken into account that approximately 2 tons of ground limestone are equivalent in their ultimate effect on the soil to 1 ton of burnt lime. This latter fact is of considerable importance when the cost of carriage of lime becomes heavy. If land is not especially in need of lime, then heavy cost of carriage may readily make the advisability of liming very questionable.

Provision of Feed Reserves.

At this period it becomes advisable to draw up the coming year's programme of special feed provision. It is quite possible that later on circumstances will call for modification of any programme drafted now, but in the meantime the programme will form the basis of decisions about such matters as cultivation work and the location of silos and fences, which should now be planned in order that labour may be devoted to them within the next few months.

Because of the abnormal season now closing, all but exceptional farms will commence the following season with reserves of feed entirely depleted. When this is the case it is most injudicious to depend for the building-up of future reserves on grass ensilage alone. There is no certainty whatever

that next summer will yield enough surplus grass growth to give reasonably safe supplies of silage, and safety in regard to supplies of the cheapest possible feed is a maxim of efficient farm-management. Hence if a farm is likely to have its current feed-reserves eliminated, then, even though extensive ensilage operations are planned for next summer, some arable cropping also should probably find a place in the coming year's programme of work.

Of seasonal interest in this connection is the fact that the mangel (which is not nearly as popular as it deserves to be) when grown after grass often gives the largest and most profitable crops as the result of May ploughing. Such ploughing allows sufficient time for the thorough decay of the buried sod and results in a more fertile soil, due partly to the rotted sod having become incorporated with it. If it is not practicable to plough at this stage, then it will be necessary in the spring to carry out either skim ploughing followed by deep ploughing, or a disking of the sod before ploughing. These alternative measures are desirable to bring about satisfactory disintegration of the sod. A buried sod if not broken up means not only a soil less rich in plant-food material, but also one in danger of drying out in the first dry spell, because such a sod checks the rise of soil-water from below it.

Autumn preparatory cultivation is also frequently advisable for carrots, potatoes, and lucerne, especially when these crops are to follow pasture. The first step should usually be skim ploughing, followed possibly by disking to break up the sod thoroughly and leave the ground in really good condition for the customary deep spring ploughing.

The Cereal Crops.

One of the most important seasonal matters relative to cereal crops is seed treatment for the control of the serious diseases which are transmitted in or on the seeds.

The best means of controlling stinking smut of wheat is dry-dusting the seed with fine copper carbonate powder. As the powder is harmful if breathed in to any extent, a suitable dust-proof mixing machine is needed for its use. Farmers not having such machines available may usually obtain supplies of treated seed from merchants. Should such treated seed not be obtainable, then the seed wheat should be pickled with formalin.

The treatment of seed oats and barley is very properly being done more generally than it was a few years ago. The copper carbonate treatment is not effective for these cereals, the seed of which requires to be treated with formalin, or seed suitably freed from disease by the hot-water treatment should be used. It is false economy to omit treating barley or oat seed on the ground that the crop will not be harvested for grain; oats infected with smut will give an inferior chaff because of loss of grain and probably also a discoloured chaff.

Serious injury of seed at times occurs on account of incorrect treatment. A description of correct methods of seed treatment was given in these notes in the March, 1930, *Journal*, and particulars may also be obtained on application to district officers of the Fields Division.

The position in regard to the manuring of cereals has been improving steadily, until much the greater portion of the total acreage of cereals is being suitably manured. On the basis of extensive experience, the use of 1 cwt. of superphosphate per acre at time of seed-sowing is recommended for wheat in the South Island. Similar manuring may be depended upon to give good results with the other cereals, which at times may respond profitably to greater amounts, particularly when bulk of green feed is a consideration.

Care of Young Stock.

As the coming winter promises to be a difficult time for much of our stock, it is well to remember that young developing animals—calves and hoggets particularly—require good attention. In New Zealand farm practice the first winter often proves the most critical period in an animal's life, because adverse influences which permanently affect its utility are so commonly operating. To avoid undue punishment, young stock should be trained to eat strange feed, particularly silage, while they are still in good condition, and before they may be called upon to subsist on such feed. Changes in feed should be carried out gradually, and if possible hoggets should be given a run-off on suitable pasture—one short and fresh—when they are being fed on special crops such as roots and chou moellier

—R. P. Connell, Fields Division, Palmerston North.

THE ORCHARD.

Autumn Spraying of Stone-fruits.

For the control of such diseases as peach leaf-curl, peach die-back, brown-rot, rust, and apricot shothole, considerable assistance can be given by the application of a fungicidal spray when the leaves are falling. It is well known that on some peaches—such as Carman, Wiggins, Elberta, and other related varieties—the application of one spray in the spring frequently fails to give good control of leaf-curl. The application of a fungicide in the autumn at leaf-fall, followed by one in the spring, is much more dependable in the control of curl on even the most susceptible varieties. In those districts growing apricots, the one spring application of a fungicide has so far not proved effective for the control of shothole on such susceptible varieties as Newcastle, and much loss is sustained through severe disfigurement of the fruit. In other countries, including South Australia and California, it appears to be the regular practice to apply a fungicide in the autumn at leaf-fall and again in the spring, with much more satisfaction than with the one spring application. Our apricot growers are therefore advised to give this treatment a trial.

The fungicide recommended for controlling disease on stone-fruits at this season of the year is bordeaux 5–4–50 (old formula), or, if hydrated lime is used, bluestone 3½ lb., hydrated lime 2 lb., water 50 gallons. Where San Jose scale is present lime-sulphur, 1 in 20 to 1 in 30, according to strength, may be substituted with good effect, although perhaps not quite so effective against leaf-curl as bordeaux.

The Orchardist's Nursery.

Most growers, especially stone-fruit growers, should have a small nursery to supply their necessary replacements. Trees may be damaged by accident beyond repair, others may be unthrifty, some may die through such diseases as silver-leaf, while others may have passed beyond the profitable stage through old age, or a variety or class of fruit may have proved unprofitable. In this and other ways in the orchards of most growers gaps appear which should be filled with young trees, while at times, also, the squaring-up of a block may require a few trees.

In practically every orchard there are one or more trees in a variety which stand above their neighbours in habit of growth, cropping, &c. If, when replacements or additions are made, the new tree is propagated from these outstanding trees, more profitable results may be anticipated and a more uniform type of fruit will be available for marketing. The planting of a few stones, the raising of a few cuttings, and the working of a few roots, together with the budding, grafting, and general attention, would not add

greatly to the work of the orchardist, and would at the same time provide a useful and profitable hobby. A portion of the vegetable garden is a convenient place for such a nursery; a piece of ground 10 ft. wide by 20 ft. long would provide quite sufficient room for 100 trees—say, ten rows each containing ten trees.

The stock at present used for apples is the Northern Spy, but as work in connection with this is unnecessary until later in the year, advice regarding raising will be deferred to a later issue. Pears are worked on to seedling pear or quince stocks, but owing to their slow rate of growth it would probably be advisable to purchase the stocks from a nurseryman. The most popular cherry stock among New Zealand growers is the Mazzard, but as it is somewhat difficult to raise it will probably be better also to purchase these stocks. Peaches and nectarines are worked on their own seedlings. Growers do not favour the peach as a stock for apricots, some leaning to seedlings of cherry-plum, Mariana plum, or apricot, and others to cherry-plum cuttings. Plums are usually worked on cherry-plum seedlings or cuttings.

If it is intended to use seedling stocks for the apricot, peach, nectarine, or plum, the stones or "pits" should be collected immediately, before they become too hard. Petrol tins cut longways will be found convenient receptables. Place a layer of 2 in. or 3 in. of moist sand in the bottom, on this put a single layer of stones, and on top put another layer of moist sand. Put the tins away in a shady place out of doors until the spring. Do not disturb the stones, but keep the soil moist. It is wise to have considerably more pits than are actually required for working the trees, to allow for misses and the elimination of the poorer seedlings.

Where cherry-plum cuttings are desired they should be attended to now. Select shoots about the thickness of a lead pencil of this season's growth which are well ripened, discarding soft whippy growths, and cover them to prevent drying out. The soil in which they are to be planted should be in good tilth and free of weeds, the top spit having been dug over. Place a garden-line along where the row is to be planted; along this line insert the spade into the soil at a slight angle to its full depth, raise it to the perpendicular, and withdraw it. Do this for a few feet along the line or the full length of the row. Now reduce the cuttings to about 12 in. to 15 in. long; make a clean cut just above the top bud and just below the bottom bud. Carefully cut off the bottom three buds with a sharp knife, cutting off the bud only, without cutting into the wood, and strip off the leaves. Insert the cuttings in the spade cut about 2 in. to 3 in. apart, by pushing them down along the hard or sloping side until the bottom of the cutting reaches solid ground. When a number have been inserted walk along the row, pressing the soil solid with the heel to ensure that there is no loose soil or air-pocket against the cutting, especially at the bottom, then rake the soil level, and the operation is complete. It is advisable to get the cuttings in as soon as possible while the soil is still warm.

Where it is intended, as with pears and cherries, to purchase the stocks, the ordering should be done now. When the trees are received they should be heeled into the ground until the soil is ready, and then be planted in the nursery rows, 2 ft. between rows and 1 ft. between the trees in the rows.

Miscellaneous.

The picking and packing of apples and pears for export and local storage will still continue. Equal care should be exercised in handling fruit for the local market as for export. Where fruit is intended to be kept in home storage the building should be well ventilated, thoroughly cleansed, and, if necessary, kept cooler by sprinkling the floor with water. The stacking of such fruit should be methodical, so that the first varieties to come out can be removed with as little inconvenience as possible.

—W. R. Lloyd Williams, Orchard Instructor, Alexandra.

Citrus Culture.

Where fresh plantings are contemplated, every consideration should be given to some of the important features that make for success.

Shelter: Without adequate shelter it is not advisable to consider planting out citrus trees of any kind. They always come away much quicker and make more definite progress in warm sheltered positions; strong winds from any direction always have a retarding effect. Trees that come away quickly and respond to manurial and cultural treatment give a pleasure to the owner, besides assuring him of quicker returns. Unless plenty of good shelter is available, defer planting out for a while or until shelter is well established.

Soil conditions: This factor also plays a very important part in citrus culture. Only well drained land lying well to the sun should be selected. Citrus trees will thrive on various kinds of soil, providing all other conditions are satisfactory. Growers should always plan well in advance when new plantings are to be undertaken. The preliminary preparation should never be overlooked, and the soil should be worked up beforehand sufficiently long to allow it to sweeten. Land broken up out of the rough and planted is not conducive to the best results. Extra time and care in the preparation is well spent, and the owner will be well repaid when he sees the results.

Selection of trees: This is a point that should not be overlooked. Trees that are indifferent or stunted should be strictly avoided; it would be preferable to wait another season than to plant out trees that are unsatisfactory. Young healthy well-grown trees should be procured, even if the cost should appear too great. A little extra invested in this way will eventually bring its own reward.

Planting: Personally I favour spring planting in preference to autumn. However, there may be certain situations that would favour autumn planting. This can only be determined after all the facts and features of the case have been considered. One important point to bear in mind is that the soil should not be wet and stodgy at planting, but reasonably dry and friable.

—L. Paynter, Orchard Instructor, Auckland.

POULTRY-KEEPING.

Colds and Ventilation.

It is usually during the coming months, when cold wet weather is likely to be experienced, that troubles are met with in the flock, particularly those troubles which have their origin in colds. It is important, therefore, for the poultry-keeper to be on the alert to detect the first sign of a cold making its appearance among his birds. The young birds, particularly pullets, are always more susceptible to colds than adult stock, and it is safe to say that thousands of pullets that are annually bred to lay during the winter fail to do so by reason of contracting colds, due in most cases to improper treatment on the part of their owners.

Where colds have given trouble in the past the poultry-keeper should immediately take measures to ensure that they are avoided in the future. He must first of all study his local conditions. Having provided proper housing designed on the deep open-fronted system, the next important point is to see that the houses are free from draughts and that the birds roost in comfort. This means that there should be no cracks in the side or back walls allowing a draught of air between the opening in the front of the house and the walls. In this connection probably more colds could be traced to the fact that the intersecting walls in a long building are not draught-proof than to any other single cause.

There are also many other causes responsible for fowls catching cold. Poorly ventilated quarters should be always guarded against, as in these the birds are apt to become overheated by night, making them susceptible to chill when they go out of doors. Then again, if colds are to be avoided it is imperative that the pullets should be protected from extremes of weather. A necessary factor is that the house be roomy—nothing less than 4 sq. ft. of floor space being allowed for each individual fowl. In such quarters the birds can be fed inside in wet weather and fed early in the evening, so that they will not be moping about in the rain waiting for feeding-time and going to roost with wet plumage, which obviously does not encourage the maintenance of good health and a maximum egg-yield.

Even though curative methods have been resorted to and with apparent success, the trouble is almost sure to recur at any time if the cause

THE VENTILATION SYSTEM TESTED AT WALLACEVILLE (SEE TEXT BELOW).

is not removed. While every precaution should be taken to prevent the birds from sleeping in a draught, the fact remains that an ample supply of fresh air in the sleeping quarters is imperative for their welfare. Here it may be mentioned that the amount of ventilation required in a house is a matter that can be decided only according to prevailing local conditions, and it is only by studying one's own local conditions that a safe course can be steered between too much and insufficient ventilation. For example, in some localities poultry-keepers have a ventilation space both at the back and at the front of the house, and the birds keep free from trouble, while in other localities if this principle of ventilation is adopted colds are almost sure to make their appearance.

A means allowing for ventilation space at both back and front of the modern fowl-house, without having any ill effect on the birds, has been tried at the Wallaceville Poultry Station, with a great measure of success.

An open space or spaces, according to the length of the house, is made between the top wall-plate and the roof, the ends of the space being in a direct line with the centre of, say, two or more rafters. On the latter a sheet of flat tin, beaver board, or asbestos slate is fixed, and is allowed to extend beyond the outside line of the perching arrangement. In this way a free current of fresh air passes through the space at the back wall and the opening at the top of the front of the house, and the birds are thus not compelled to sleep in a direct draught. This system of ventilation not only provides the birds with plenty of fresh air without draught, but it also greatly tends towards keeping the litter from getting into an over-wet state, which is a common occurrence during the wet winter season, and especially where the birds are overcrowded. The accompanying photo shows how easily this simple and inexpensive system of ventilation can be arranged.

Reverting to the matter of colds, when it is observed that dust and dirt are adhering to the nostrils it is a safe indication that the birds have contracted a cold, the nasal discharge causing the dust and dirt to adhere. Then follows sneezing, with a watery discharge from the eyes. When a cold has reached this stage prompt measures should be taken to stamp out the trouble, for too often the neglected cold develops into the dangerous roup. If the breath becomes offensive, and a swelling or a cheese-like substance protrudes from the eyes, it indicates that the cold has developed into roup. A cold may be treated successfully, but once the roup stage has been reached it will usually pay to destroy the bird at once rather than attempt to doctor it.

Prevention is always better than remedial treatment, but where the trouble has made its appearance treatment is, of course, necessary. Affected birds should be at once isolated, and placed in the most comfortable quarters possible. The best treatment is probably to hold the beak of the bird in kerosene in such a way that the nostrils are submerged and to keep the bird in this position until it breathes. This should effect a cure after several applications. Before treatment any adhering matter should be removed from the nostrils, while after each operation any kerosene remaining on the beak should be wiped off with a dry cloth, care being taken to see that no kerosene gets on the face, as if it does blistering will probable follow. It may be again emphasized that the poultry-keeper should take every precaution against allowing even a slight cold making its appearance by removing all sources favourable to its development. Remember that the curing of colds involves considerable labour and loss in eggs.

Feather-pulling.

Inquiries regarding fowls losing their feathers have been frequently received during recent months. In some cases this has been looked upon as an unseasonable moult. One owner states that many of his birds have been casting their feathers for months past, and have produced heavily at the same time. He asks if it is not exceptional for birds to moult and lay well. In other cases the owners have been at a loss to know the cause of their birds becoming half naked and generally presenting an unsightly appearance. It is feather-pulling, however, and nothing else. This is a bad habit and is usually the result of overcrowding, insufficient exercise, and the presence of vermin, the latter in most cases being responsible. The parasite which is chiefly responsible causes intense irritation of the skin. The fowl, in order to get rid of the irritation caused by the insects at the roots of the feathers, may pull out a feather herself, but generally invites her mates to do so.

When birds have acquired this habit it will be usually noticed first on the neck and breast of a bird, and if a male bird is in the pen he will probably be the first to be attacked. As with most other troubles that

affect poultry, the best way of dealing with feather-pulling is to prevent it by removing the cause, for if once the majority of birds in a flock acquire the habit it will prove a difficult matter to overcome. It is commonly stated that feather-pulling is due to some element required by fowls being deficient in the ration provided, and it is therefore often held that an ample supply of animal food, frequent changes of diet, or adding flowers of sulphur or salt to the morning mash, will have the desired result. It is also often recommended that if the feathers surrounding the bare patches are bathed with a bitter solution this will break the habit. I have seen all these remedies tried but with no avail. The first essential is to wage constant war on vermin by keeping the houses clean and giving them a frequent spraying with a strong disinfectant. Ample space for the birds to exercise must also be provided. Where space does not allow a good grass-run, or where the birds are being kept in the house and no outside runs are provided, the birds should be compelled to exercise by covering the floor of the house with litter in which all grains should be fed. The chief preventive, however, is to see that the birds are free from these kinds of insect pests that continually live on the body of fowls.

The best method of dealing with this class of vermin is by applying black leaf 40 (a by-product of tobacco) to the perches. From 2½ lb. to 3 lb. of this preparation will be sufficient to free a thousand birds of any lice that may be upon them. The material for this number can be effectively applied in about fifteen minutes, and the following is a good way of doing so: Make a small hole in, say, a cocoa-tin, place the liquid in it and pass it along each perch, leaving a thin line of the liquid on the perch. Do this at dusk just when the birds are going to roost. For the treatment to be really effective it is important that all birds should go or be placed on the perches, and not allowed to roost in odd corners of the house. If there is much dust on the perch the liquid is apt to run off and become wasted, and to prevent this it is a good plan to first rub the perches over with a damp cloth. If this is done the liquid can be more easily applied to the centre of the perch, and the risk of wastage will be reduced to a minimum. The treatment should be repeated in, say, ten days, after which time the birds should keep fairly free from vermin for about three months.

F. C. Brown, Chief Poultry Instructor, Wellington.

THE APIARY.

Removal of Supers.

AMONG the autumn work which must not be neglected is removal of the supers, and this should be undertaken as soon as the extracting-combs are cleaned up by the bees. It is bad management to leave the bees more space than they can occupy. By removing the supers the space in the hive is restricted, and consequently it is much easier to make the bees snug and warm for winter. Where the strength of the colony will permit this to be done, nothing is to be gained by leaving on the supers. However, it may be impossible in the case of strong colonies to confine the bees to the brood-chambers, in which case the supers can be left on the hives until the spring. By that time most of the bees will be in one story, and the supers can then be removed.

A good plan to follow in getting the bees to clean up the combs is to insert a mat, in which a small hole has been cut, between the brood-chamber and the super. The bees, finding the combs partly cut off by the mat, lose little time in removing the surplus honey. At this operation the excluders should be removed from the hives, and stored away until such time as they can be cleansed of burr combs. A little care is necessary in dealing with the excluders, so as not to bend the wires. They can be readily cleansed by plunging them into boiling water.

Winter Stores.

The losses attendant upon starvation are no less serious a menace to the beekeeper than disease. While disease is met with from time to time, each autumn brings the problem of wintering the bees, and while the professional will prepare his colonies so as to guard against serious losses, the average beekeeper is apt to overlook the essentials that make for success. There are factors such as shelter, watertight hives, vigorous young queens, &c., which all play a part in the wintering problem; but, above all, a supply of food sufficient to meet the colonies' wants must not be overlooked. The safe wintering of bees is a test of a beekeeper's capabilities, as he is called upon to gauge the amount of stores required to tide his bees over the period between the autumn flow and the appearance of the early nectar-secreting plants. Locality plays an important part, more especially where autumn flows are unknown and fine autumn weather prevails. In these districts the consumption of stores is greater, and a constant watch must be kept on the hives so as to determine the amount of food required to guard against loss, as breeding will be carried on until a later period in the season.

Various estimates have been given as to the amount of food required to winter the cluster, varying from 30 lb. to 40 lb., and experience has proved that, providing a colony is left with this amount, it will not only winter well but will build up rapidly in the spring. In any case, it is by far the safest policy to leave an excess of food rather than run the risk of leaving the colony short and with barely enough to tide it over the dormant period. Where the amount of stores is less than 30 lb. the shortage can be made up quickly by the insertion of a few combs of honey. Calculating on the basis that a full comb contains 6 lb. of honey, it is easy to estimate the weight of honey in the hive. If, however, combs of honey are not available, feeding should be undertaken. This latter operation should not be delayed till the cold weather, but commenced early in the autumn.

For supplementing the stores, sugar syrup, fed in the proportion of two of sugar to one of water, is the best substitute for honey. Avoid using inferior qualities of sugar: none but the best white sugar should be fed. In feeding to augment the winter food supply it is often necessary to give large quantities of syrup, and consequently large feeders must be adopted. The Miller and the division-board feeders are excellent for this purpose. The former enables about 10 lb. to 25 lb. of stores to be fed at one time. It is designed to be placed inside the super or upper story on top of the brood-frames, and has two compartments for syrup, the passageway for the bees being in the centre through the bottom, directly over the cluster. The division-board feeder is popular, and enables about 5 pints of syrup to be fed. Hanging between the frames, all that is necessary is to turn back the mat so that the opening in the top is exposed. The main advantage of this feeder is that food can be supplied without exposing the cluster and without the aid of smoke.

Shelter Essential.

As in the spring, a vital necessity at this time of the year is shelter for the hives. Brood-rearing must be encouraged if the bees are to go into winter quarters sufficiently strong to give good results the following season. If a shelter-hedge or fence has not been provided an excellent temporary breakwind can be erected with manuka scrub. Shelter without too much shade is the life of an apiary, and on no account should large trees be utilized as a means for protecting the hives. The spaces between the trunks are productive of draughts, and the high branches exclude too much of the sunlight. A live hedge 8 ft. to 10 ft. high is the ideal shelter for an apiary.

Foul-brood.

The risk attendant on carrying over diseased bees is too great, as the trouble is more likely to be spread in the autumn and spring by robbing. In cases where weather conditions have prevented successful treatment, or in which disease is detected on making a final examination prior to putting the bees into winter quarters, it is advisable to remove all combs showing the slightest signs of disease. Where disease is detected in a bad form nothing will be gained by holding the colony over for treatment, and by far the safer plan is to destroy it.

—E. A. Earp, Senior Apiary Instructor, Wellington.

HORTICULTURE.

Planting Bush Fruits and Passion-vines.

In the cooler districts black currants and red, gooseberries, and raspberries flourish ; but warmer temperatures are necessary for passion-vines, loganberries, tree-tomatoes, feijoa, and guava.

With the commencement of the planting season, during the month of May, most of these crops may be planted to advantage if the preparation of the land has been successfully accomplished. On no account should it be done otherwise ; better is it to plant later, or even defer it for twelve months, than to set out the plants in land newly broken up and that has not sweetened, or land still infested to some extent with difficult perennial weeds. As most of these fruit crops are comparatively permanent the cultivation should be deep, and generous quantities of green cover-crops or farm manure should be turned under and given time to decay before planting is done. To avoid those extreme alternating conditions of stagnant waterlogged and dry hard soil that are so disastrous to crops, the land should be drained where they occur, and given time to improve ; and, as practically all of the crops mentioned were originally inhabitants of the forests, ample shelter is beneficial and even necessary for satisfactory results.

In the richer moist loams black currants, loganberries, and raspberries thrive best. Planting at a distance of 3 ft. between plants and 6 ft. between rows will best suit most varieties of black currants grown here. Under best conditions of soil and climate loganberries are planted 9 ft. apart both ways ; otherwise the spacing may be reduced a foot or so. This crop requires the support of a wire trellis or fence ; 7 ft. posts, 2 ft. in the gound, 30 ft. apart, and stakes between as necessary, would be suitable. On rich land three wires fixed 2 ft., 3 ft. 6 in., and 5 ft. from the ground respectively would generally be best ; otherwise two may be sufficient.

Raspberry-canes are sometimes planted in groups of three, 5 ft. to 6 ft. apart both ways ; but in rather greater favour now is the method of planting single canes 1 ft. apart and 5 ft. between the rows. Low posts, with double wires about 3 ft. from the ground, keep the cropping canes in line and out of the way of cultivation.

A drier and more open position is suitable for currants, red and white, and also gooseberries ; 5 ft. to 6 ft. apart both ways is suitable spacing.

The fruit of the passion-vine (*Passiflora edulis*) has now a firm place in popular estimation, and its unique qualities will no doubt ensure a lasting esteem. It has only been planted in small numbers until recently, and experience with large areas suggests some modification in methods. The best spacing under most conditions is 10 ft. between plants and 9 ft. between rows, making 480 plants to the acre. A good trellis is required for the support of the plants ; that described for loganberries is suitable, except

perhaps that the top wire of the trellis may be duplicated, fixing one on each side of the top of the post. A stake should be placed at each plant so that it may be trained to the top of the trellis before branching.

The fragrant feijoa and the guava so much in demand for making jellies have not yet been grown here commercially to any extent, but they have decided possibilities in the warmer districts when care is taken to secure superior varieties. These evergreens are often recommended to be planted rather close in the row to form a cross-shelter in less exposed positions.

As previously stated, most of these crops are best planted during the month of May in well-prepared land, but loganberries and passion-vines are more often planted in the spring. Some Auckland growers advocate autumn planting for passion-vines, as the plants are not so likely to suffer from drought, but more often they are grown from seed on the spot. Spring planting is also suitable for the tree-tomato (*Cyphomandra betacea*), which specially requires good shelter from winds.

As no fruit is to be obtained from these crops during the first season, it is sometimes desirable to grow a crop in the alleys for that period. Potatoes, peas, beans, &c., may be sown, but no risk should be taken that is likely to check the development of the main crop. The pruning of the latter is best left after planting until just before growth commences.

The Tomato Crop: Insect Pests and Virus Disease.

The little grub with the grand name of *Gnorimoschema melanoplintha* did a lot of damage to the tomato crops last season, but little has been seen and less heard about it during the season just closing. The dry summer experienced in most districts was all in its favour, so it is fair to conclude that the treatment given was effective in protecting the plants, which is satisfactory so long as we do not fail to be vigilant in due season. However, if it is not one thing it is another. This season a large parcel of fruits with yellow spots that had become rather familiar on ripened fruit was carefully examined, and the condition was declared to be caused by a virus disease. Most diseases are due to fungus or bacterial organisms, but regarding the cause and nature of virus diseases comparatively little is known at present. What information is available, however, demands careful consideration if loss is to be avoided. Potato crops have long suffered from the attack of this mysterious enemy, and many other garden plants (chiefly annuals), also some weeds.

There are evidently different diseases of this class, but a common symptom is a mottled colouring of the part affected, including sometimes on leaves and fruit the yellow colours before referred to; blistered, distorted, or narrow leaves, and the ensuing stunted growth, are further symptoms. They may, of course, vary in intensity; under adverse conditions the plants may wither up and die, or under good management only one or two of the symptoms may be present, and those not very noticeable.

On the other hand, patchy ripening of the fruit and a chlorotic (light-green and yellow) colouring of the leaf may be due, as we know, to unsuitable soil-conditions or badly balanced feeding with chemical fertilizers, while a stunted condition may be due to any number of causes.

But there is one important difference in this apparent similarity of symptoms. When the symptoms are due to virus disease they are very infectious, which is not the case under other circumstances. The juice from a plant suffering from virus disease has only to be smeared on the surface of any portion of a healthy plant that is but slightly injured to transmit the trouble. Such inoculations readily take place when one is pruning, suckering, or disbudding a plant; or, what is considered one of the commonest methods, the inoculation takes place by means of sucking

insects, such as thrips or aphides. The disease can be propagated, of course, by planting infected cuttings or tubers, and in the opinion of some by taking seeds from an infected plant.

In the circumstances it is necessary to watch and study the crops carefully in order to note the first signs of trouble, and by taking prompt action much work or great losses may sometimes be avoided. In seasons when sucking insects are numerous we have now additional reasons for controlling their increase so far as possible. When pruning and tying tomato plants those that may be affected should be trimmed last, and when selecting plants for seed-bearing the first consideration should be to see that they are free from serious disease. In addition to these precautions, it is unwise to leave useless infected plants about; they should be carefully collected and burnt. Also weeds, especially those of the same natural order, should be carefully suppressed, as in many instances they also are hosts from which the virus may be transmitted.

The Vegetable Garden.

During May carrots, lettuce, cabbage, cauliflower, and broad beans are sometimes sown, chiefly in the warmer districts; and in frost-free localities peas and early potatoes are sown for harvesting in early summer.

Where new land is to be broken in an early start should be made. Besides the necessary labour it takes time to rot the sod and sweeten the soil to make it clean and fertile. More failures are due to the neglect of this precaution than to any other cause.

Trim the hedges well back to stiffen them and prevent encroachment on useful land. In wet localities see that ditches and drains are well cleaned out, so that storm-water has a ready clearance.

Where slow-acting manures are to be used on land for early planting, they may be turned in now or harrowed in after ploughing. Lime, kainit, basic slag, and blood and bone manure come under this heading. It is usually advisable to vary the diet of plants and apply potash and phosphate in different forms.

Club-root Control.

A report on the successful experiments in club-root control recently completed at the Plant Research Station, Palmerston North, was reviewed in these notes on page 143 of the February *Journal*. An inadvertent error has since been noticed in the third paragraph, where the amount of burnt lime printed as 1 oz. per square yard should have been *1 lb.*

W. C. Hyde, Horticulturist, Wellington.

Grazing of Pigs.—The fact must not be lost sight of that the pig is a natural grazer and has been provided by nature with all the facilities for grazing. In the past it has not been thought worth while to give this side of feeding much prominence on account of most farmers having a good supply of skim-milk or whey to be fed to the number of pigs they were raising. Owing, however, to the fall in prices of butter and cheese, and the decreased revenue obtained from the farm generally, many breeders and feeders of pigs are considering the advisability of increasing their pig stocks. If kept under the old system, with a proportionately lesser amount of skim-milk or whey, this would be impossible unless supplemented by bought foods. But with the addition of adequate top-dressed grass pastures, suitably divided and rotationally grazed, a much larger number of pigs may be reared and fattened with the same amount of skim-milk or whey. At the same time the animals concerned will benefit by the exercise obtained from grazing, and also by the high food-content which is always to be found in good young grass. Grazing should become a prominent feature in the future raising of our pig stocks, and this system, supplemented with dairy-products, meat-meal, and grain-meals, may be considered a sound economic practice.

WEATHER RECORDS: MARCH, 1932.

Dominion Meteorological Office.

MARCH was remarkable for the very dry weather experienced over the greater part of the Dominion, and for the prevalence of southerly or south-easterly winds. Though temperatures were on the average rather below normal, the coolness was mitigated by a comparative absence of wind. Many days were beautifully warm.

Rainfall.—Several heavy rains were experienced in the Auckland Peninsula, especially the northern portion. The totals for the month exceeded the average in all parts, but in the far North were more than double. The districts east of the main range from Hawke's Bay to East Cape also had a continuance of the wet conditions prevailing in February, and the total falls were considerably above the average. The only other area which recorded more than the normal for March was that about Dunedin. In the remainder of the country the rainfall was generally much below average. In the southern half of Taranaki, and in the Wellington, Marlborough, and Canterbury Provinces, very light falls were recorded. For example, Eltham had only 0·07 in., Foxton 0·61, Wellington 0·35, Spring Creek, Blenheim, 0·24, and Christchurch 0·48 in.

Temperature.—Though, as would be expected with southerly winds prevailing, most places had temperatures rather below the average for March, this was by no means invariably the case. In some localities, especially those protected from the direct effect of south-easterly winds, a warm month was experienced.

Sunshine.—Conditions varied somewhat, but at the majority of places there was less sunshine than normal.

Winds.—There were strong south-easterly to north-easterly winds about Cook Strait and over the North Island between the 6th and the 10th, some rather heavy gales being reported from the North, but, on the whole, winds were unusually light during the month.

Weather Systems.—The outstanding feature of the weather charts during the month was the prevalence of anticyclones over New Zealand. This was particularly noticeable at the beginning and the end of the month. Generally, the centre of high pressure was in the South, and this accounted for the frequency of south-easterly winds. The usual westerly depressions were few in number and very poorly developed.

From the 6th to the 9th, while pressure was very high to the south and south-east, a depression moved from far to the north of New Zealand in a south-south-easterly direction, past Chatham Islands. Heavy rains occurred in North Auckland and between Hawke's Bay and East Cape, many rivers being flooded.

Rains were caused in parts of the same districts between the 18th and 20th under rather similar conditions, pressure being high to the south and relatively low to the north.

Following this a cyclone gradually developed in the North Tasman Sea, while pressure remained very high to the east of New Zealand. The cyclone crossed the southern portion of the South Island on the 23rd, and northerly gales were experienced in some places. This storm was the only one during the month which produced anything approaching general rains, but on this occasion there were few localities which recorded no rain, and heavy falls occurred in most. The heaviest were in the northern and north-eastern portions of the North Island and the western and southern portions of the South Island. Some flooding again occurred.

RAINFALL FOR MARCH, 1932, AT REPRESENTATIVE STATIONS.

No.	Station.	Total Fall.	Number of Wet Days.	Maximum Fall.	Average March Rainfall.
	North Island.				
		Inches.		Inches.	Inches.
1	Kaitaia	5·50	7	2·79	2·94
2	Russell	9·98	8	2·25	2·77
3	Whangarei	9·23	9	2·94	4·23
4	Auckland	3·68	8	1·98	3·01
5	Hamilton	1·97	5	1·43	3·81
6	Rotorua	2·78	6	1·56	3·51
7	Kawhia	1·08	4	0·49	3·51
8	New Plymouth	2·11	5	1·29	3·75
9	Riversdale, Inglewood ..	3·09	5	2·70	7·12
10	Whangamomona	2·58	3	1·30	5·07
11	Eltham	0·07	1	0·07	4·05
12	Tairua	6·56	10	2·22	5·13
13	Tauranga	3·87	8	2·59	3·98
14	Maraehako Station, Opotiki	3·27	11	1·94	4·00
15	Gisborne	5·48	15	2·51	4·40
16	Taupo	1·67	5	0·88	3·19
17	Napier	4·80	12	1·77	3·16
18	Hastings	2·29	16	0·79	2·78
19	Taihape	0·51	5	0·28	2·69
20	Masterton	0·57	9	0·19	2·86
21	Patea	0·32	3	0·15	3·46
22	Wanganui	0·52	2	0·50	2·52
23	Foxton	0·61	5	0·20	2·05
24	Wellington	0·35	5	0·18	3·11
	South Island.				
25	Westport	5·33	11	2·00	7·50
26	Greymouth	2·58	5	1·28	8·91
27	Hokitika	3·99	6	2·38	9·74
28	Ross	4·01	5	1·44	11·03
29	Arthur's Pass	2·17	3	1·27	11·38
30	Okuru	2·59	6	1·18	14·70
31	Collingwood	3·12	4	1·46	5·97
32	Nelson	0·76	4	0·24	2·96
33	Spring Creek	0·24	2	0·23	2·05
35	Hanmer Springs	0·84	5	0·38	3·28
36	Highfield, Waiau	0·61	5	0·30	2·89
37	Gore Bay	0·57	4	0·25	2·23
38	Christchurch	0·48	9	0·22	1·98
39	Timaru	0·96	10	0·30	2·24
40	Lambrook Station, Fairlie ..	..	..	..	2·38
41	Benmore Station, Clearburn	0·69	2	0·57	2·78
42	Oamaru	0·70	5	0·55	1·80
43	Queenstown	0·72	2	0·64	2·64
44	Clyde	1·03	2	0·99	1·50
45	Dunedin	3·04	9	2·24	2·94
46	Wendon	2·97	6	2·22	2·73
47	Gore	..	..	..	3·25
48	Invercargill	3·25	10	1·80	3·89
49	Puysegur Point	3·88	12	1·14	8·20
50	Half-moon Bay	2·87	11	0·92	5·52

Noxious Weeds Order.—The Hawera County Council has declared gorse and Cape daisy to be noxious weeds within the county.

ANSWERS TO INQUIRIES.

IN order to ensure reply to questions, correspondents must give their name and address, not necessarily for publication, but as a guarantee of good faith Letters should be addressed to the Editor.

PIGS WITH LUMPS AND SWELLINGS.

M. B., Waimamaku :—

We have some sty-fed pigs about five months old, and they have developed lumps or carbuncles near their knee-joints and other parts of their bodies ; also one has an ear that looks as if it has been inflated with air, as it is thick and swollen. The pigs are fed on thick separated milk and a small amount of green stuff. Would they be fit for use if the lumps disappear ? The lumps are as large as a walnut and just under the skin.

The Live-stock Division :—

This trouble seems to me to be due to some infection or inoculation of the skin with organisms that set up the inflammation and possibly an abscess. We would hardly attribute it to the feeding, although it would be a wise thing to make a change. Allow the pigs plenty of green stuff, and add some Glauber salts to their feed once every week. A dessertspoonful per head mixed in the feed would be a suitable dose. For local treatment give them a rub over with flowers of sulphur and lard—one of sulphur to eight of lard. As hygienic measures, put the affected animals in isolation, and thoroughly disinfect the sty and flooring with formalin and water—a breakfast cup to a kerosene-tin full (4 gallons). Once they have recovered thoroughly there is no reason why they should not be fit for use.

CARRYING-CAPACITIES OF PASPALUM AND RYE-GRASS.

E. L. TANSEY, Napier :—

Can you furnish me with any data as to the comparative carrying-capacity of (1) paspalum and white clover, and (2) rye-grass and white clover pastures, on very rich alluvial flats in a district practically free from frost ? Also their comparative value for fattening, mainly sheep ? Both paspalum and rye-grass seem to do exceptionally well.

The Fields Division :—

Rye-grass and paspalum produce their maximum growth at different periods of the year, and in consequence the maximum carrying-capacity of either would vary accordingly at different periods. In your case, where both paspalum and rye-grass do exceptionally well, you are advised to establish a well-balanced mixture of the two, together with white clover. The combination, provided the pasture is well managed and utilization good, is excellent, for the reason that the paspalum by its vigorous growth during the warmest and driest weather covers the weakest period of the growth of rye-grass ; and in like manner during winter, spring, and early summer the rye-grass covers the weakest period of paspalum growth. Such a pasture should be adequately top-dressed in the autumn, which boosts the rye along through the winter and spring until the paspalum takes up the running in the warmer and drier period. Needless to say, such a mixture is ideal for fattening sheep, provided it is well controlled.

Size of Eggs important.—Too many side-line poultry-keepers fail to attach due importance to the size of eggs produced. In mating up the breeders it is especially important to know that the cockerel has come from a hen laying a good-sized egg, for however satisfactory the size of the eggs of the female are, the progeny will probably fail to maintain a good egg standard if the sire is the descendant of stock the eggs of which were of a small size. It should be remembered that the male bird influences perhaps hundreds of the progeny, whereas a hen only influences the chickens which have come from the eggs she laid.